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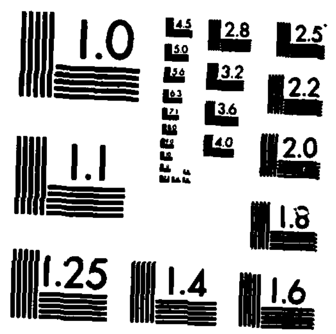

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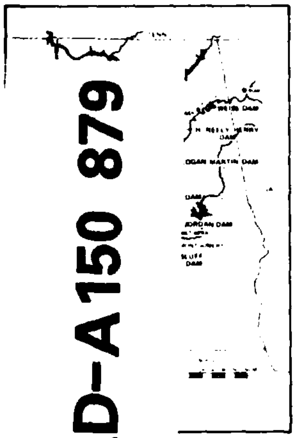

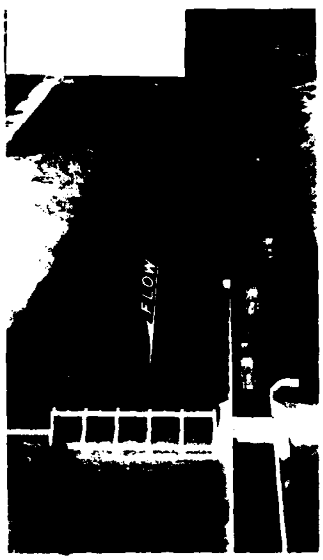

HYDRAULICS
LABORATORY

TECHNICAL REPORT HL-84-11

12

NAVIGATION CONDITIONS IN VICINITY OF WALTER BOULDIN LOCK AND DAM COOSA RIVER PROJECT

Hydraulic Model Investigation

by

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December 1984
Final Report

Prepared for

DEPARTMENT OF THE ARMY
US Army Engineer District, Mobile
Mobile, Alabama 36628

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Report HL-84-11

2. GOVT ACCESSION NO.: A150 899

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): NAVIGATION CONDITIONS IN VICINITY OF WALTER BOULDIN LOCK AND DAM, COOSA RIVER PROJECT; Hydraulic Model Investigation

5. TYPE OF REPORT & PERIOD COVERED: Final report

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s):
Carolyn M. Myrick
John J. Franco

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
US Army Engineer Waterways Experiment Station
Hydraulics Laboratory
PO Box 631, Vicksburg, Mississippi 39180-0631

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:

11. CONTROLLING OFFICE NAME AND ADDRESS:
US Army Engineer District, Mobile
PO Box 2288
Mobile, Alabama 36628

12. REPORT DATE: December 1984

13. NUMBER OF PAGES: 129

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Coosa River (Ala.)--Navigation (LC)
Hydraulic models (LC)
Jordan Reservoir (Ala.) (LC)
Navigation--Alabama--Coosa River (LC)
Walter Bouldin Lock and Dam (Ala.) (LC)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Walter Bouldin Lock will be the first navigation lock proposed for development of navigation on the Coosa River Waterway. The lock will be located in the left overbank area of Walter Bouldin Dam. The model investigation was concerned with navigation conditions in the reach, including the Jordan Reservoir, the intake diversion canal, the Walter Bouldin Reservoir, and the Walter Bouldin tailrace.

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Continued).

Three fixed models were constructed to an undistorted scale of 1:100 to study navigation conditions at three locations in the reach where navigation difficulties were anticipated.

Model A reproduced the Walter Bouldin Lock and Dam, Reservoir, and tailrace.

Model B reproduced the Jordan Reservoir and entrance to the intake diversion canal.

Model C reproduced the confluence of the Walter Bouldin tailrace and the Alabama River.

Results of the investigation indicated ~~the following~~:

a. No serious navigation difficulties should be experienced through the Jordan Reservoir and in the entrance to the diversion canal.

b. Because of high velocities and crosscurrents, navigation conditions could be hazardous through the Bouldin Reservoir when the pool is below el 248.0 even with a 220-ft-wide channel and the bottom at el 233.0. No serious navigation difficulties were indicated with a pool at el 252.0 and a 220-ft-wide channel.

c. With a steady powerhouse flow of 27,000 cfs and low tailwater, tows with sufficient power to overcome the high-velocity currents could negotiate the powerhouse tailrace and lower lock approach channel without serious difficulties. However, lock emptying and start of powerhouse units would create surges that would be hazardous to navigation within the lock approach channel and in the reach downstream to below the confluence of the tailrace and the Alabama River, particularly with low tailwater.

d. Hazardous conditions in the lower reach at the entrance to the lock canal could be reduced from 30 min to about 10 min after approach of the surge by increasing lock emptying time to at least 15 min and start of Bouldin powerhouse units at intervals of at least 10 min or by maintaining a high tailwater elevation. Surges hazardous to navigation could also develop when closing down one or more powerhouse units.

PREFACE

The model investigation reported herein was authorized by Office, Chief of Engineers, US Army, in 2nd Indorsement, dated 23 April 1979, to the Division Engineer, US Army Engineer Division, South Atlantic (SAD). The study was conducted for the US Army Engineer District, Mobile (SAM), in the Hydraulics Laboratory of the US Army Engineer Waterways Experiment Station (WES) during the period January 1981 to January 1983.

The investigation was conducted under the general supervision of Messrs. H. B. Simmons, Chief of the Hydraulics Laboratory, and F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory, and under direct supervision of Mr. J. E. Glover, Chief of Waterways Division. The engineer in immediate charge of the model was Mr. L. J. Shows, Chief of the Navigation Branch, assisted by Mr. R. T. Wooley and Mrs. C. M. Myrick. This report was prepared by Mrs. Myrick and Mr. J. J. Franco.

During the course of the model study, representatives from SAM, SAD, US Geological Survey, Alabama Power Company, and Southern Company Services visited WES at different times to observe special model tests and discuss results. SAM was informed of the progress of the study through monthly progress reports and special reports at the end of each test.

Commanders and Directors of WES during the course of the investigation and the preparation and publication of this report were COL Tilford C. Creel, CE, and COL Robert C. Lee, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, US CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

US customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
miles (US statute)	1.609344	kilometres
square miles (US statute)	2.589988	square kilometres

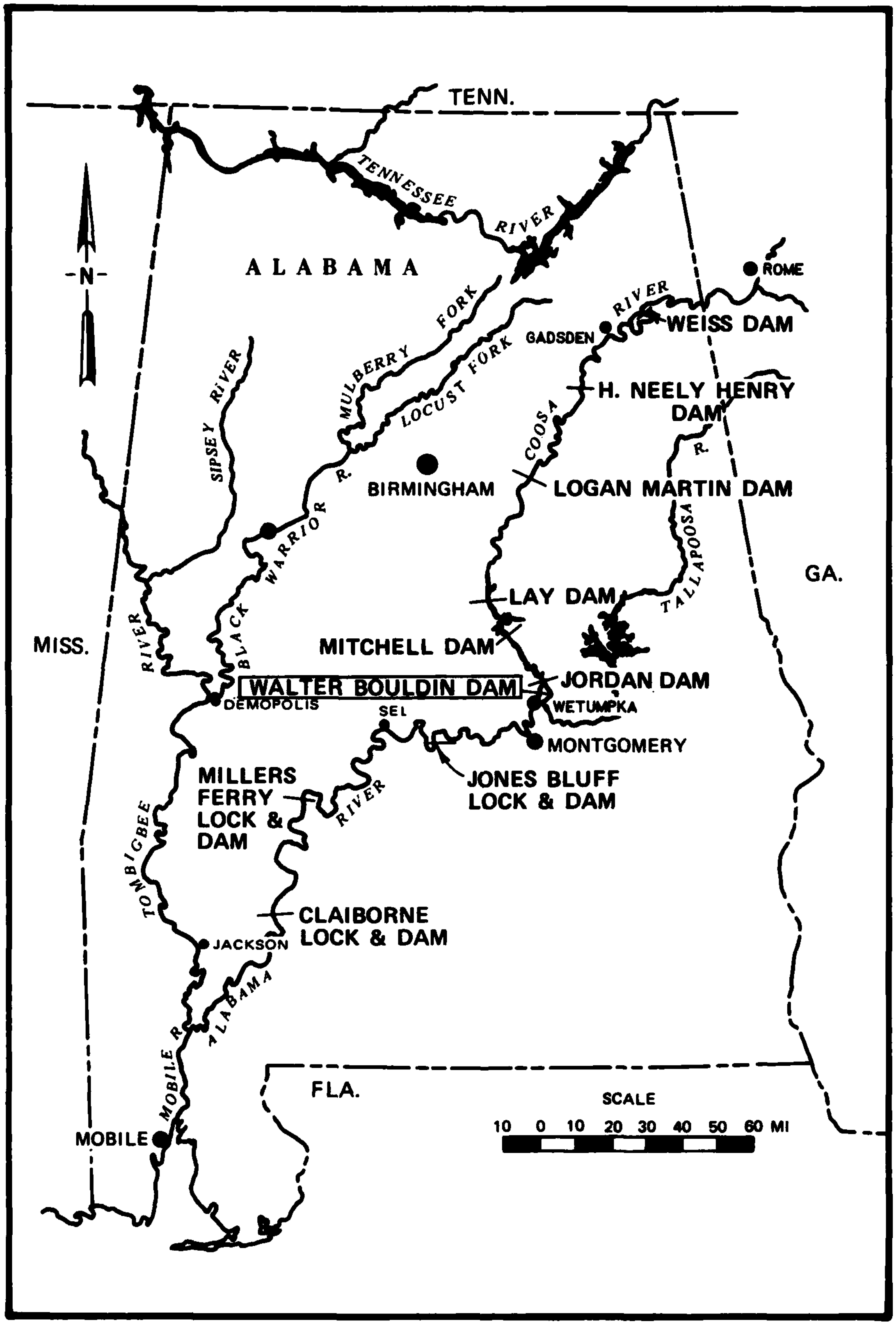

Figure 1. Vicinity map

NAVIGATION CONDITIONS IN VICINITY OF WALTER BOULDIN LOCK AND DAM, COOSA RIVER PROJECT

Hydraulic Model Investigation

PART I: INTRODUCTION

Description of Prototype

1. The Coosa River is formed by the confluence of the Oostanaula and Etowah Rivers near Rome, Georgia, and flows southwesterly about 286 miles* to Wetumpka, Alabama, where it joins with the Tallapoosa River to form the Alabama River (Figure 1). The river drains an area of about 10,200 square miles. Presently, six dams are located on the stream of which the Jordan Dam is the farthest downstream with an additional dam on a dredged canal. The Walter Bouldin Dam and hydroelectric plant (an auxiliary generating unit to the powerhouse at the Jordan Dam) are located along the west bank of the Coosa River on a dredged canal extending from Jordan Reservoir (river mile 20) to a point on the Alabama River near Wetumpka, Alabama, about 1 mile downstream of the junction of the Coosa and Tallapoosa Rivers.

2. The dam consists of a total length of approximately 10,950 ft of earth fill including 228 ft of gravity concrete section. The powerhouse is equipped with three generating units each with a maximum discharge capacity of about 9,600 cfs. The Walter Bouldin Dam has no spillway or pool regulating facilities.

History of Project

3. The River and Harbor Act of 1945 authorized development of the Alabama-Coosa River system for navigation, flood control, and power development. In June 1954, Public Law 436 suspended authorization for Federal hydropower development on the Coosa River to permit the Alabama Power Company to develop the river from the vicinity of Montgomery, Alabama, to Rome, Georgia,

* A table of factors for converting US customary units of measurements to metric (SI) units is presented on page 3.

by construction of a series of hydropower dams. An interim report printed in House Document 320 in January 1960 recommended that the navigation project for the Coosa River from Montgomery to Gadsden, Alabama, be accomplished after the waterway to Montgomery was assured. It recommended that the project for the reach between Gadsden and Rome be accomplished when the waterway to Gadsden was assured and economic justification of the extension established.

4. The Alabama River Project providing navigation to Montgomery was completed in January 1972.

5. The Alabama Power Company has constructed seven Coosa River hydropower dams. The dams were planned, constructed, and rights-of-way reserved to permit future development of navigation on the Coosa River through the addition of locks at six sites.

Present Development Plan

6. The principal features of the authorized Coosa River navigation project provides for installing navigation locks at the existing Alabama Power Company's Walter Bouldin, Mitchell, Lay, Logan Martin, and H. Neely Henry Dams for the waterway to Gadsden and constructing a 9- by 150-ft navigation channel.

7. Walter Bouldin Lock is proposed for construction in the left overbank area of the dam. The lock will have clear chamber dimensions of 84 by 600 ft, a maximum lift of 130 ft, and the necessary entrance and exit channels.

Need and Purpose of Model Study

8. The general design of the Walter Bouldin Lock was based on sound theoretical design practice and experience with similar structures. However, conditions through the reach approaching and leaving the lock could be expected to be extremely complex because of the effects of currents approaching and leaving the powerhouse, irregular channel alignment and configuration, limited channel width, high velocities, crosscurrents, and surges from changes in powerhouse releases and lock filling and emptying. Also, navigation conditions vary with location and flow conditions upstream and downstream of a structure, and an analytical study to determine hydraulic effects expected to result from a particular design is both difficult and inconclusive. Therefore a comprehensive model study was considered necessary to determine:

a. The navigation conditions that would result in the upper and lower lock approaches for various riverflows and lock approach entrance and exit configurations, and the effects of lock filling and emptying and powerhouse releases.

b. Navigation conditions entering and leaving the lower end of the dredged diversion canal between Jordan and Walter Bouldin Reservoirs and through the Bouldin Reservoir.

c. Navigation conditions within the Jordan Reservoir and in the entrance of the diversion canal.

d. Navigation conditions at the junction of the Walter Bouldin tailrace and the Alabama River.

e. Modifications that could be used to eliminate or minimize any undesirable conditions indicated.

PART II: THE MODELS

Description

9. The study involved the investigation of navigation conditions at three locations that were a considerable distance apart (Figure 2). In the interest of economy and to facilitate operation and testing, a model was constructed for the study of each of the three conditions. These models, designated Models A, B, and C, were of the fixed-bed type with the channels and overbank areas molded of sand-cement mortar to sheet-metal templates set to proper grade. Portions of the models, where changes in bank alignments and channel configurations could be anticipated, were molded in pea gravel to facilitate modifications that might be required to develop satisfactory conditions. The lock, lock auxiliary walls, powerhouse, and portions of the dam were constructed of sheet metal. The models are described as follows:

- a. Model A (Figure 4, page 15). Reproduced the dam and powerhouse of Walter Bouldin Reservoir and about 2,000 ft of the lower reach of the diversion canal between the Jordan and Bouldin Reservoirs, about 9,500 ft of the tailrace canal, and the adjacent overbank areas. Also included were the proposed lock and approach channels. This model was designed to study navigation conditions approaching and leaving the locks, effects of powerhouse releases, and lock filling and emptying.
- b. Model B (Figure 13, page 36). Reproduced the essential features of Jordan Reservoir affecting navigation conditions in the approach to the diversion canal connecting that reservoir to the Walter Bouldin Reservoir. The model included about 7,000 ft of the Jordan Reservoir and about 3,000 ft of the upper reach of the diversion canal. This model was designed to study navigation conditions for tows approaching and leaving the upper end of the canal.
- c. Model C (Figure 14, page 39). Reproduced the junction of the Walter Bouldin tailrace and Alabama River about 1 mile downstream of the mouths of the Coosa and Tallapoosa Rivers, and included about 2,700 ft of the lower reach of the tailrace canal and the Alabama River channel about 1,500 ft above and about 4,400 ft below the junction of canal and river and adjacent overbank. The model was designed to study navigation conditions in the lower reach of the tailrace canal and in the entrance to the canal from the river.

10. The channel portions of the models were molded to the January-May 1981 hydrographic survey, and the overbank areas for Models A and B were

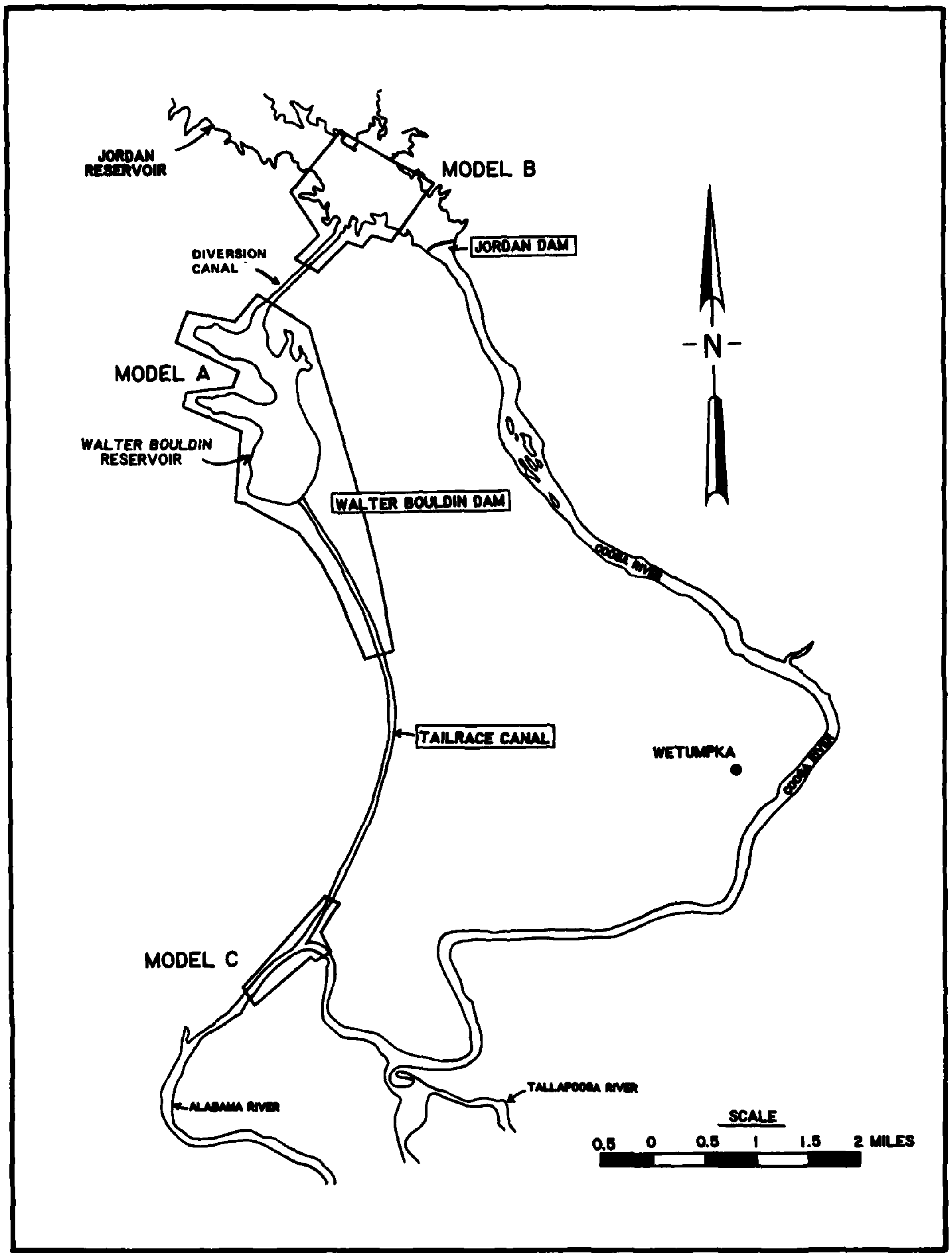

Figure 2. Location map

molded to the September 1980 topographic survey and for Model C to the December 1980 topographic survey.

Scale Relations

11. The models were built to an undistorted linear scale ratio of 1:100, model to prototype, to obtain accurate reproduction of velocities, crosscurrents, and eddies that would affect navigation. Other scale ratios resulting from the linear scale ratio were as follows:

Area	1:10,000
Velocity	1:10
Time	1:10
Discharge	1:100,000
Roughness (Manning's n)	1:2.15

Measurements of discharges, water-surface elevations, and current velocities can be transferred quantitatively from model to prototype equivalents by means of these scale relations.

Appurtenances

12. Water was supplied to the model by means of a 10-cfs pump operating in a circulating system. The discharge was controlled and measured at the upper ends of the models by means of valves and venturi meters or Van Leer weirs. Water-surface elevations were measured by means of piezometer gages located in the model channel and connected to a centrally located gage pit. A tailgate was provided at the lower end of each model to control the established tailwater elevations for the discharges tested. Slide type gates in the powerhouse were used to maintain the upper pool elevation of the Bouldin Reservoir and to control powerhouse releases. Surges were measured with continuous recording gages placed at selected ranges.

13. Velocities and current directions in the model were determined by means of wooden cylindrical floats weighted on one end to simulate the maximum permissible draft for loaded barges using the waterway (9 ft prototype). A model towboat and tow were used to determine and demonstrate the effects of currents on tows approaching and leaving the lock and in critical reaches of

the project. The towboat was equipped with twin screws and was propelled by two small electric motors operating with a battery in the tow. The rudders and speed of the tow were remote-controlled, and the tow could be operated in forward or reverse at a speed comparable to that of towboats expected to use the Coosa River waterway.

Model Adjustment

14. The model surface was constructed of brushed cement mortar to provide a roughness (Manning's n) of about 0.0135 which corresponds to a prototype roughness of about 0.029. With the existing dam and powerhouse in place, the model was checked against available prototype data which consisted mostly of water-surface elevations with various flow conditions and surges created by starting two powerhouse units simultaneously. Results indicated that the model reproduced the existing prototype condition with a reasonable degree of accuracy (Figure 3). See Figure 5 for the locations of the surge stations.

Test Procedures

15. Tests were concerned primarily with the study of flow patterns, measurement of velocities, surges, and water-surface elevations and the effects of currents on the movement of the model tows approaching and leaving the lock and in critical reaches with various flow conditions.

16. The following representative flows and water-surface elevations were used for testing based on information furnished by the US Army Engineer District, Mobile:

a. Walter Bouldin Lock and Dam (Model A)

(1) Powerhouse discharge 18,000 cfs with upper pool el 242.0,* 245.0, and 252.0 and TW el 124.4.

(2) Powerhouse discharge of 27,000 cfs with upper pool el 242.0, 245.0, 248.0, and 252.0 and TW el 124.0.

b. Jordan Reservoir (Model B). Riverflows of 30,000, 90,000, and 175,000 cfs at upper pool el 252.0 and 248.0 with flows of 0 and 27,000 cfs through the canal between Jordan and Bouldin Reservoirs.

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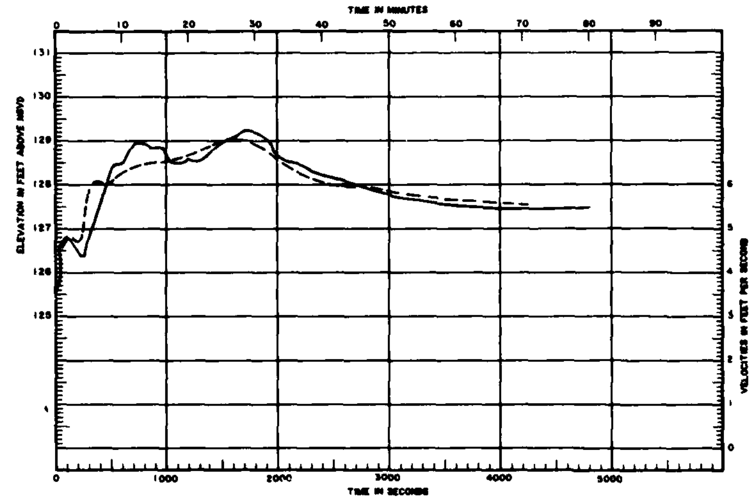
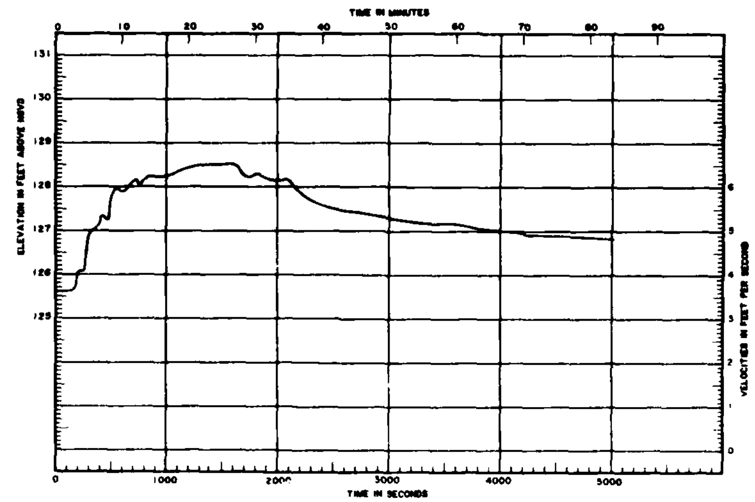
* All elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD).



STATION 1



STATION 4

LEGEND

— MODEL DATA

-- PROTOTYPE DATA

POWERHOUSE 0-18,000 CFS

INITIAL TAILWATER 125.6 FT

Figure 3. Walter Bouldin Lock and Dam, Coosa River; velocities and surges, adjustment test

c. Confluence of Alabama River and tailrace canal (Model C)

(1) Total riverflow of 30,000 cfs with TW el 125.3 with various portions from tailrace canal.

(2) Total riverflow of 60,000 cfs with TW el 137.1 with various portions from tailrace canal.

(3) Total riverflow of 90,000 cfs with TW el 147.1 with various portions from tailrace canal.

(4) Total riverflow of 155,000 cfs with TW el 156.8 with various portions from tailrace canal.

17. The riverflows were reproduced by introducing the proper discharge, setting the tailwater elevation for the discharge, and in the case of Model A, manipulating the powerhouse gates until the required upper pool elevation was obtained. All stages were permitted to stabilize before data were recorded except during lock filling and emptying and changes in powerhouse releases. Start of powerhouse units was assumed to be instantaneous.

18. Velocities were determined by timing the travel of floats over measured distances. Current directions were determined by plotting the paths of floats with respect to ranges established for that purpose. In plots of currents in turbulent areas or where eddies or crosscurrents existed, only the main trends are shown in interest of clarity. No data were obtained with the model tow, except to observe and record on multiple exposure photographs its behavior as affected by currents in the lock approaches through the reach. Continuous slope and velocity recording meters were used to measure surge and velocities during lock emptying and start of powerhouse releases. On Model A, surge data were taken at 1,000 ft (sta 1) and 7,000 ft (sta 4) downstream of the powerhouse and at 300 ft (sta 2) and 3,300 ft downstream of the end of the guide wall as shown in Figure 5. Surge data on Model C were taken in the tailrace at 1,000 ft upstream of the confluence (sta 1-A), at the confluence (sta 2-A), and in the Alabama River at 1,000 ft downstream of the confluence (sta 3-A) as shown in Figure 15.

PART III: BOULDIN LOCK AND DAM (MODEL A)

Original Design

Description

19. The original design (Figure 4) proposed for the lock and navigation channel included the following principal features:

- a. The existing three-unit powerhouse and a separate navigation lock with clear chamber dimensions of 84- by 600-ft located in the left overbank; a 600-ft-long ported upper guide wall with top el 259.0 and a 427-ft-long lower guide wall with top el 158.0.
- b. The channel in the upper lock approach dredged to el 227.0 with a bottom width of 150 ft.
- c. A 150-ft-wide navigation channel in the upper pool dredged to el 233.0 along the alignment shown in Figure 4.
- d. A 240-ft-wide lower lock approach canal dredged to bottom el 107.0.

Results - upper pool

20. Water-surface elevations shown in Table 1 indicate the effects of upper pool elevation on slopes through the channel extending from the diversion canal to the locks. The slopes were generally high (about 1.3 to more than 2 ft/mile) with the lower pool elevation and reduced to near zero with the higher pool of 252.0.

21. Current directions and velocities shown in Plates 1-6 indicate the effect of pool elevation on velocities and alignment of currents. Currents in the upper reach of the approach canal follow the bend in the dredged channel with the higher velocities concentrating along the right or concave side of the bend. Maximum velocities in the upper reach varied from about 6.7 to 8.2 fps with the 18,000- and 27,000-cfs flow and lower pool elevation. In the reach farther downstream, maximum velocities varied from 8.7 to more than 9 fps for both flows. Velocities in the approach to the lock and powerhouse were considerably lower. Also, velocities were considerably lower through the entire reach with the higher pool elevations.

22. Currents generally followed the alignment of the dredged channel after leaving the diversion canal connecting the Jordan and Bouldin Reservoirs but became rather irregular farther downstream particularly with the lower pool. Currents in the approach to the lock were affected by the knoll

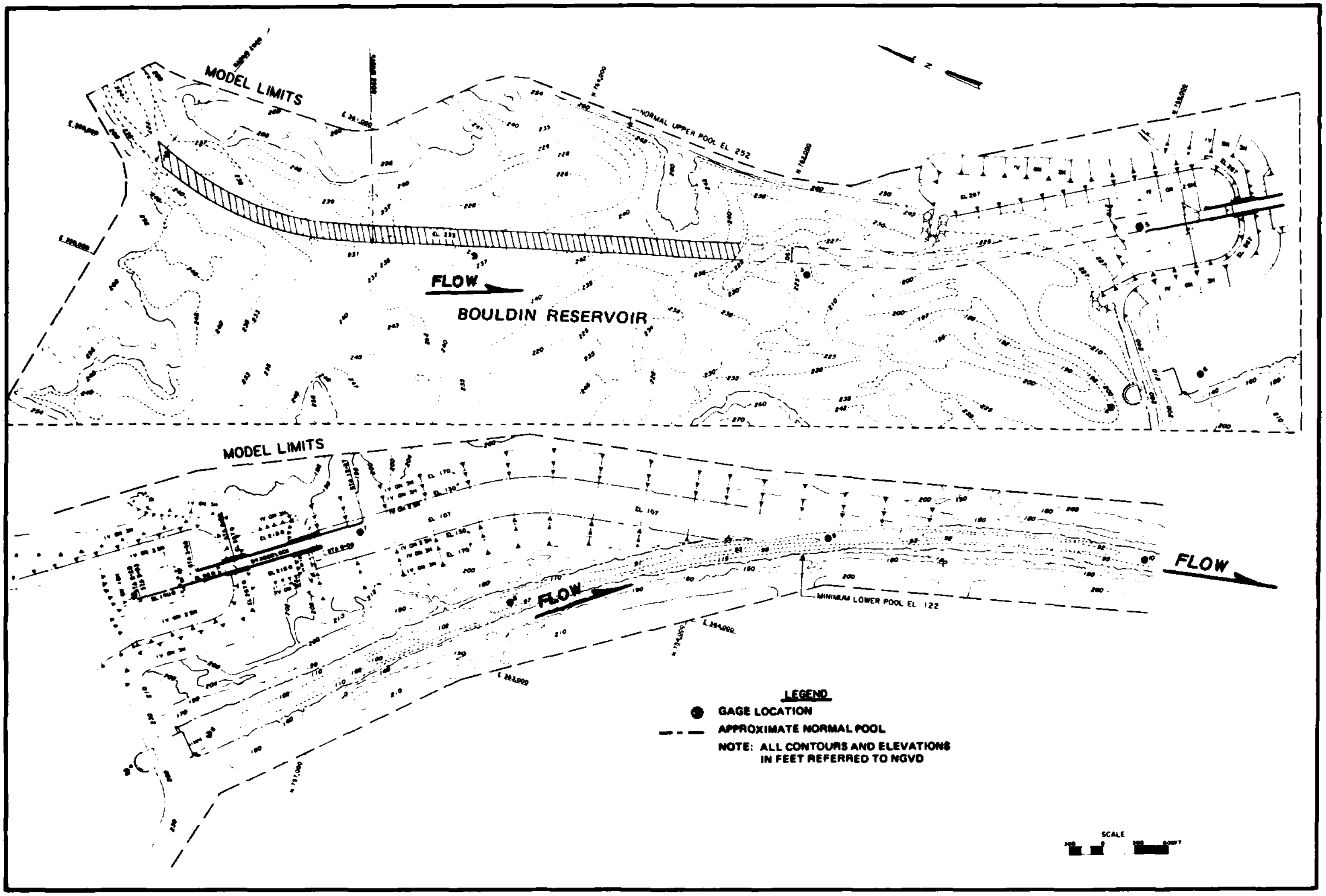


Figure 4. Bouldin Lock and Dam, Model A, original design

extending out from the right side into the reservoir causing a large clockwise eddy to form downstream with all of the conditions tested. A counterclockwise eddy was formed in the entrance to the lock which was affected to some extent by the cells extending from the left bank just upstream.

23. Downbound tows leaving the diversion canal would experience considerable difficulties in the reach upstream of the lock because of the high velocities and irregular currents. With the low pool (el 242.0), conditions would tend to be extremely hazardous. With the higher pools (el 245.0 and 252.0), there was a tendency for tows to be pushed aground along the right side of the channel just downstream of the canal entrance by currents leaving the canal and near the knoll along the right side of the reservoir about a mile upstream of the lock. Downbound tows approaching the lock would be affected by the currents moving toward the powerhouse and the need to avoid hitting the cells on the left bank upstream of the lock. However, tows maintaining adequate control could approach the lock with the higher pools without any serious difficulties. Upbound tows would be affected by the high velocities and crosscurrents, but tows with sufficient power could negotiate the reach with the 245.0 and 252.0 pool elevations. Lock filling would have practically no effect on navigation conditions in the upper lock approach with any of the pool elevations tested.

Results - lower pool

24. Steady flow. Water-surface elevations shown in Table 1 indicate a slope of about 1.6 ft/mile with the 27,000-cfs flow in the reach downstream of the entrance to the lock approach channel. Maximum velocities across the entrance to the lock approach channel were about 4.7 fps with the 18,000-cfs flow (Plate 3) and about 6.0 fps with 27,000-cfs flow (Plate 6). Downstream of the entrance, maximum velocities increased to about 6.4 to 6.7 fps for the two flows. The alignment of currents was generally parallel to the bank lines except for a counterclockwise eddy that formed in the entrance to the lock approach channel. With constant flow, no serious navigation difficulties were indicated for upbound tows with sufficient power to negotiate the high-velocity currents.

25. Surges. Lock emptying and start of powerhouse releases can be expected to create surges that could seriously affect navigation. Results of these tests with lock emptying in 8.5 min and instantaneous powerhouse releases are shown in Plates 7-18. The effect of lock emptying a short distance

below the powerhouse (sta 1)* shown in Plate 7 indicate an initial surge of about 3.8 ft above and 2.4 ft below normal tailwater elevations with no flow through the powerhouse. The surge would continue for a considerable time but decrease in magnitude after the initial surge. With steady powerhouse flow and a higher tailwater elevation, the magnitude of the inital surge was less and decreased much faster. Lock emptying with no powerhouse flow caused a rapid increase in water level of about 2.9 ft and 2.6 ft at sta 2 and 3, respectively, with peak velocities of about 5.8 and 5.5 fps (Plate 8). Downstream of the lock entrance channel (sta 4), the increase in water level was only slightly less than that in the lower end of the lock approach channel with a peak velocity of about 3.3 fps. A second peak in the velocity curve occurred at sta 4 caused by flow returning from the surge in the tailrace channel below the powerhouse.

26. With powerhouse releases of 27,000 cfs, the effect of lock emptying was somewhat less and the duration of the surge was considerably less than without powerhouse flow (Plates 7, 9, and 10). The surges downstream of the lock and at the lower end of the lock approach channel were about 3 and 2 ft with peak velocities of about 3 and 4 ft, respectively. In the reach downstream of the lock approach channel, the surge was about 2 ft but peak velocities were about 7.7 fps. Increase in the tailwater elevation caused a small decrease in the magnitude of the surge with little effect on peak velocities in the lock approach channel. Peak velocities downstream of the approach channel were reduced to about 6.5 fps.

27. Powerhouse releases. Effects of instantaneous powerhouse releases on water-surface elevations and velocities are shown in Plates 11-14. Starting of one or more powerhouse units caused a rapid increase in the water level in the lock approach canal of about 2.4, 3.4, and 4.3 ft with the start of one, two, and three units, respectively. Increases in water-surface elevation downstream of the lock approach channel were about the same as those in the approach channel but the rate of increase was considerably less. Peak upstream velocities in the lock approach channel varied from about 4.5 fps at the lower end to about 3.6 fps downstream of the lock with the start of three powerhouse units. Peak velocities downstream of the approach channel varied from about 2.3 fps with one unit to about 4.5 fps with the start of two and three units.

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* Locations of surge stations are shown in Figure 5.

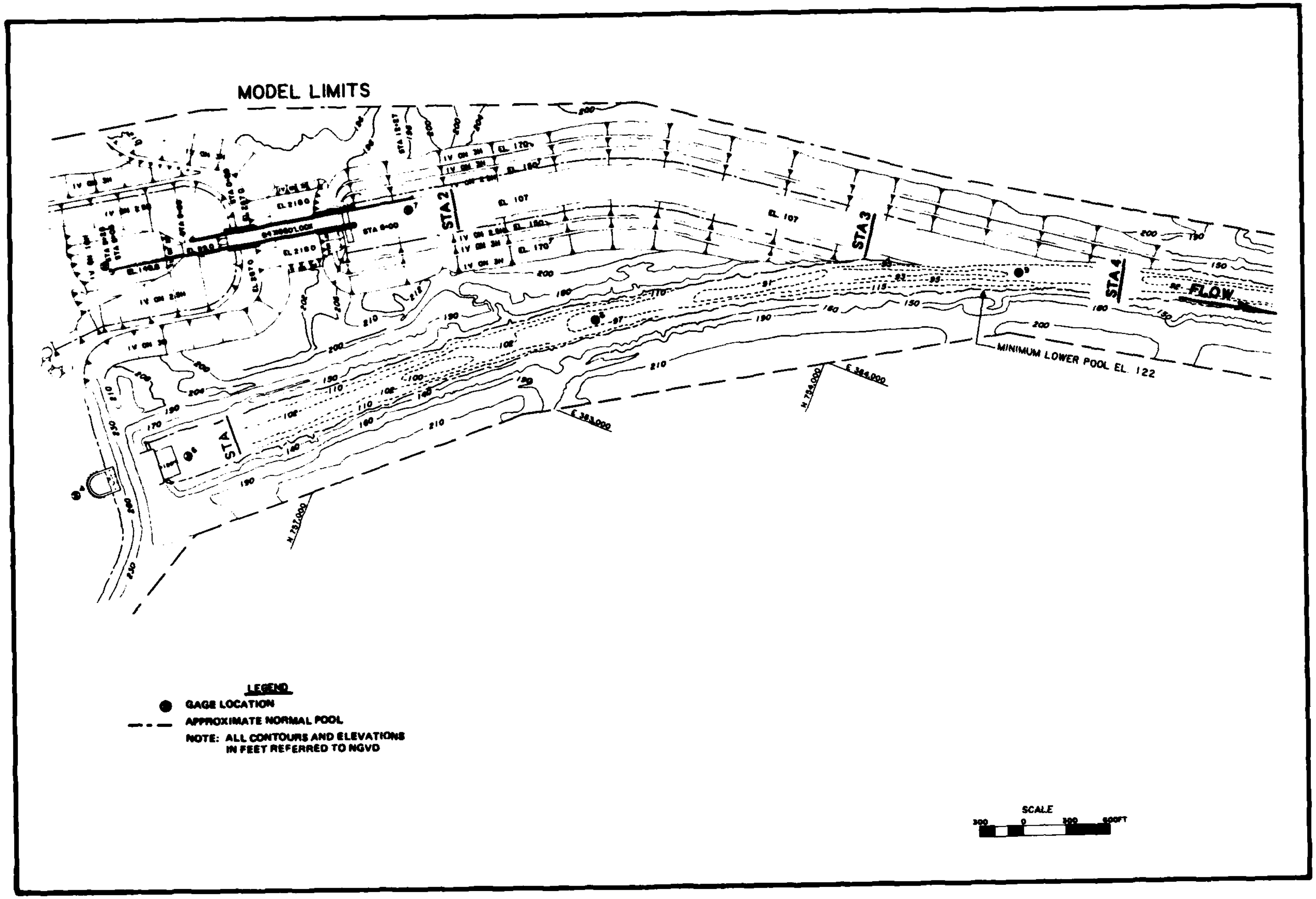

Figure 5. Bouldin Lock and Dam surge stations, Model A

The rate of increase in velocities was rather small with one and two units and increased considerably with three units. With the start of three powerhouse units there was a variation in the velocity and direction of the currents near the lower end of the lock approach canal that lasted for about 40 min (Plate 13). With a higher tailwater elevation of 157.4 ft, the initial increase in water level downstream of the lock (sta 7, Plate 14) was about 1.7 ft with the start of three powerhouse units; the second surge that occurred some 25 min later was about 0.8 ft higher.

28. Lock emptying with start of powerhouse releases. Effects of lock emptying with start of powerhouse releases are shown in Plates 15-18. The start of lock emptying with the start of three powerhouse units produced a rapid rise in water-surface elevation in the lock approach channel of about 3 ft which could be attributed mostly to lock emptying with peak velocities of 5.2 fps near the lock (sta 2). After the initial rise, water-surface elevations continued to increase over a period of about 30 min but velocities decreased rapidly. In the reach downstream (sta 14), there was a rapid rise of about 4.5 ft with peak velocity of about 5.5 fps.

29. Delay in lock emptying of 5 min after start of three powerhouse units produced a rapid increase in water-surface elevations near the lock of 6.5 ft with considerable variations for about 30 min. Peak velocities were about 3.4 near the lock (sta 2) and about 4.3 near the lower end of the lock approach channel (sta 3). In the reach downstream of the lock approach channel, the rise in water-surface elevation was about 5.5 ft that occurred over a period of about 8 min with a peak velocity of about 4.5 fps.

30. Delay of lock emptying for 10 min after start of releases of three powerhouse units produced an initial increase in water-surface elevation of about 4.5 ft and an additional increase of 1.9 ft shortly afterward just downstream of the lock. Currents initially were in an upstream direction with a peak of 1.8 fps and then reached a peak downstream velocity of about 3.1 fps. At the lower end of the lock approach channel (sta 3), there was a peak upstream velocity of about 4.3 fps and that changed rapidly to a downstream velocity of about 4.4 fps. Conditions in the channel downstream of the lock approach channel (sta 4) were better with the delay in lock emptying resulting in a more gradual increase in water-surface elevation of about 5.5 ft with little variation thereafter; velocities also increased gradually to a peak of about 4.3 fps.

31. A delay of 15 min in the start of lock emptying after the start of three powerhouse units produced conditions somewhat better than with the 5- and 10-min delay. Just downstream of the lock there was an initial increase in water-surface elevations of about 4.5 ft, then a decrease of about 1 ft, and another increase of about 2.8 ft. There was a peak upstream velocity of about 1.3 ft and sometime later a peak downstream velocity of about 2.7 fps. Near the lower end of the lock approach channel (sta 3), peak upstream velocity was about 4.3 fps, the same as with the 10-min delay in lock emptying. Peak downstream velocity was about 4.3 fps and the increase in water level was more gradual than in the previous test. In the reach downstream of the lower lock approach (sta 4), the rise in water-surface elevations of about 6.2 ft extended over a longer period with peak velocity of about 4.3 fps.

32. Navigation conditions. Lock emptying and start of powerhouse releases can have serious adverse effect on navigation approaching or leaving the lock because of the rapid changes in velocities, current alignment, and in some cases, direction of flow particularly in the lock approach channel. With lock emptying and no powerhouse flow, a tow near the entrance to the lock approach canal would tend to be pushed aground on the right bank. Tows within the canal would encounter a rapid increase in velocities. Surges in the lock approach canal would produce hazardous navigation conditions for a period of about 30 min after start of lock emptying with no powerhouse flow and for about 20 min with a steady flow of 27,000 cfs from the powerhouse.

33. Start of powerhouse releases would create surges that would extend into the lower lock entrance canal with currents moving upstream and then downstream. Conditions would tend to be hazardous for tows in the lower lock approach for about 10 min after the start of one powerhouse unit and about 35 min after the start of three powerhouse units simultaneously. Start of lock emptying and three powerhouse units at the same time would increase the rate of rise in water-surface elevations and in velocity of currents that would tend to be hazardous for navigation for a period of about 20 min after start of the operation.

34. With steady flow, upbound tows with sufficient power to overcome the high-velocity currents should experience no serious difficulties in negotiating the reach downstream of the lock. Because of the velocity of currents, downbound tows could experience some difficulty in maintaining control within the limited channel width.

Plans A and A-1

Description

35. Plans A and A-1 were modifications of the original design developed in an effort to improve navigation conditions through the Bouldin Reservoir and in the lower lock approach. These modifications involved the following (Figures 6 and 7):

- a. The channel through the Bouldin Reservoir and in the upper approach was realigned and its width increased to 220 ft with the bottom elevation of 233.0.
- b. A canal was excavated across the island between the powerhouse tailrace channel and the lower lock approach channel. The canal in Plan A had a bottom width of 220 ft at el 107.0 with side slopes of 1V on 2.5H. In Plan A-1, the bottom width of the canal was reduced to 50 ft.

Results - upper pool

36. Water-surface elevations shown in Table 2 indicate little change in the upper pool compared with the original design except for a small increase in the upper reach with the lower pools.

37. Current direction and velocities. The alignment of currents shown in Plate 19 indicates that with the lower pool (el 242.0) currents tend to move toward the left after leaving the upper bend and then to the right and back to the left. Velocities in the upper reach were about the same as those with the original design but increased toward the downstream reaching a maximum of more than 11 fps. The eddy downstream of the knoll extending into the reservoir upstream of the powerhouse increased in size and intensity. With the 245.0 pool elevation, the currents followed the same general pattern as with the 242.0 pool elevation; velocities were considerably lower but higher than those with the original design (Plate 20). With the high pool of 252.0, the alignment of the currents was considerably better and velocities were much lower.

38. Navigation conditions. In the Bouldin pool, navigation conditions would tend to be extremely hazardous with the low pool elevation of 242.0 because of the high velocities and irregular alignment of currents. Although conditions were better with the 245.0 pool elevation, tows would experience difficulties in maintaining proper alignment and could be in danger of grounding. No serious navigation difficulties were indicated with the pool at el 252.0. In general, conditions were somewhat better with Plan A and the

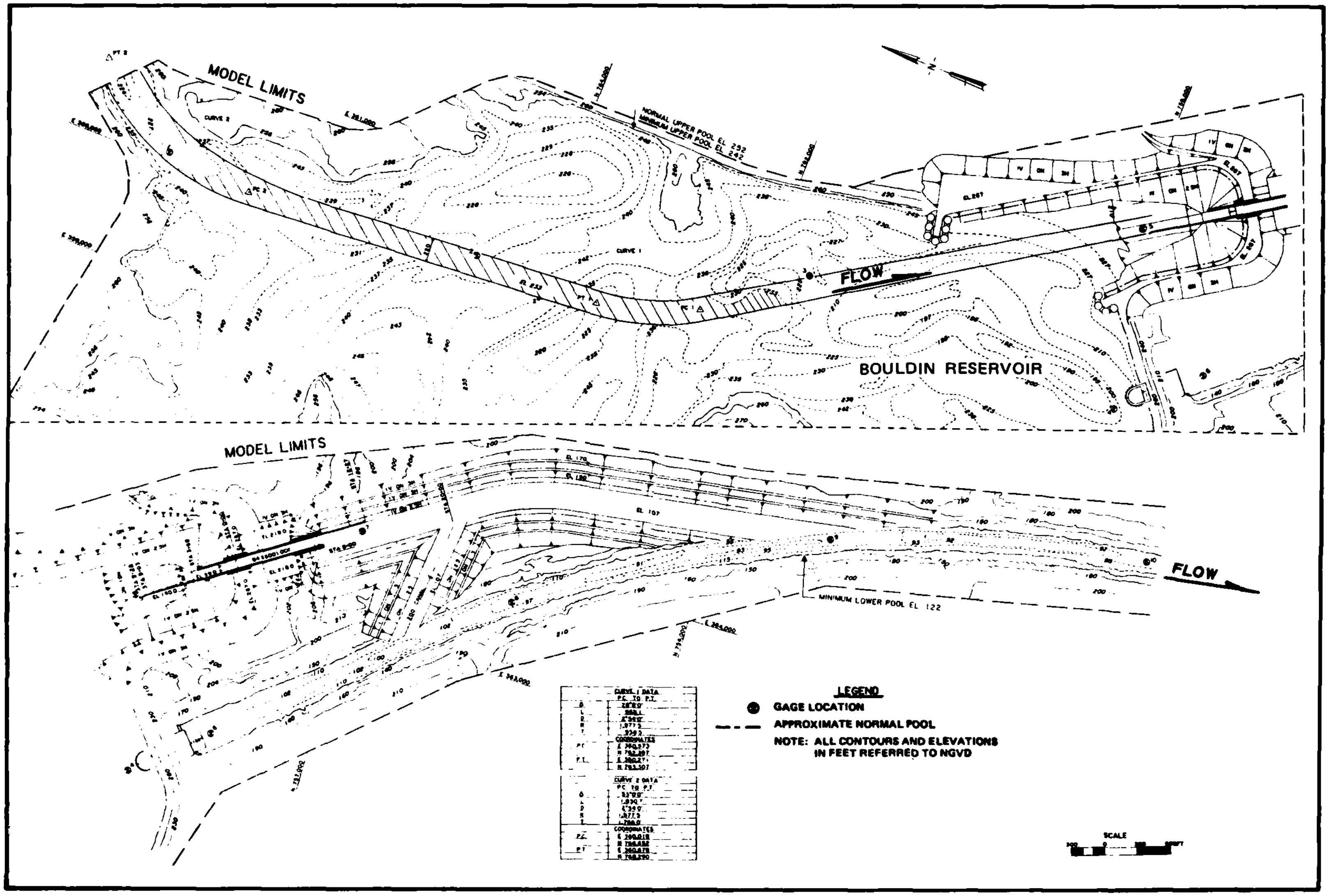

Figure 6. Bouldin Lock and Dam, Model A, Plan A

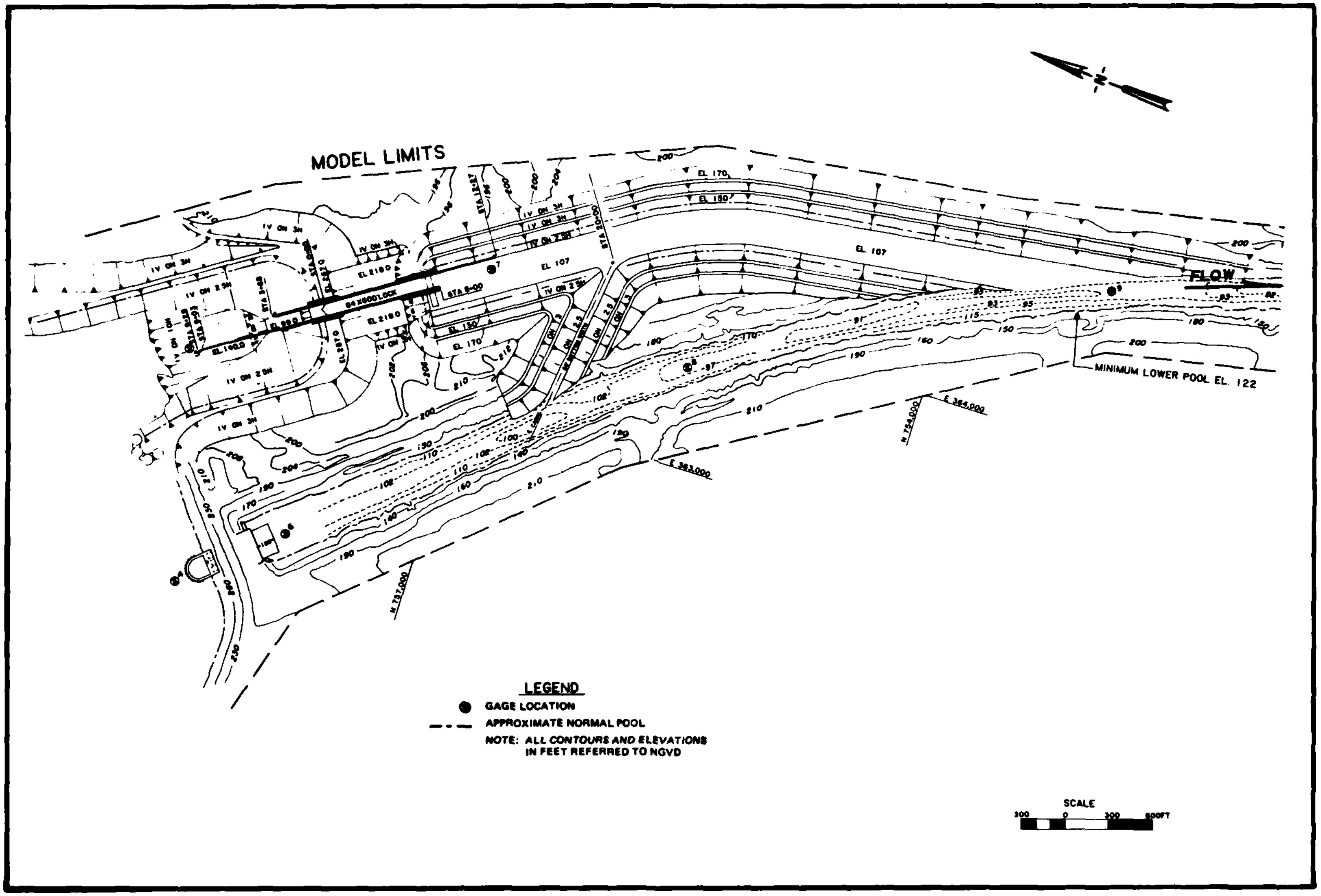

Figure 7. Bouldin Lock and Dam, Model A, Plan A-1

higher pool than those with the original design, principally because of the wider channel.

Results - lower pool

39. Current direction and velocity. With three powerhouse units in operation, flow through the canal between the powerhouse tailrace and lower lock approach channel produced currents across the lock approach channel with a velocity as high as 3.9 fps (Plate 21). Velocities across the entrance to the lock approach canal were lower than with the original design and the eddy was eliminated. Reducing the size of the canal between the tailrace and the lock approch channel (Plan A-1, Plate 22) reduced velocities from the canal across the lock approach channel. There was little change in conditions at the lower end of the lock approach channel. Navigation conditions for tows approaching or leaving the entrance to the lock approach channel were better than those with the original design. Tows passing the canal across the island between the tailrace and lock approach channel could be affected by flow across the channel but the effect would tend to be small, particularly with Plan A-1, and could be passed without serious difficulty.

40. Lock emptying. There was little difference in the effect of lock emptying just downstream of the lock (sta 2) with no powerhouse flow between the original design and Plans A and A-1 (Plates 23 and 24). Farther downstream (sta 3) the surge was smaller with considerably lower velocities; also the surge damped faster. Conditions were somewhat better with Plan A-1 than with Plan A. Improvement was also noted downstream of the lock approach channel (sta 4). The initial surge during lock emptying could cause tows to be grounded at the entrance to the canal between the tailrace and lock approach channel. However, tows could negotiate the reach about 8 min after start of lock emptying.

41. Effects of lock emptying with a discharge of 27,000 cfs through the powerhouse are shown in Plates 25 and 26. Results indicate that generally the effect of lock emptying on surges would be less than with no powerhouse flow and considerably better with Plan A than with Plan A-1. Peak velocities in the lock approach channel varied from about 3.4 to 4.0 fps with Plan A-1 with higher velocities occurring near the entrance (sta 3).

42. Starting powerhouse releases. Start of powerhouse releases produces a rapid increase in water-surface elevations in the lower lock approach channel and downstream depending on the number of units started simultaneously.

Effects of starting three powerhouse units are shown in Plates 27 and 28. Results indicate a steady rise in water-surface elevations with relatively small surges in the lock approach channel. There was a surge in velocities at sta 3 with Plan A reaching a peak of about 1.3 fps. Conditions were somewhat better with Plan A-1 than those with Plan A. The canal across the island between the powerhouse tailrace and the lock approach channel produced a considerable improvement in navigation conditions compared with the original design. No serious navigation difficulties were indicated with Plan A except for the initial surge near the canal that would tend to move a tow against the banks of the lock approach channel during the start of three powerhouse units. Navigation conditions with Plan A-1 were similar to those of Plan A except at the entrance to the lock canal the initial surge would tend to push the tow aground on the left bank. These conditions would be eliminated in about 10 min after start of the units.

43. Start of powerhouse releases and lock emptying. Effects of starting three powerhouse units and lock emptying are shown in Plates 29-32. Start of three powerhouse units produced an initial surge downstream of the powerhouse (sta 1) that involved a rapid rise in water-surface elevation of about 2.9 ft, a drop of about 2 ft, and a rapid rise of about 3.5 ft. Simultaneous start of three powerhouse units and lock emptying eliminated most of the surge. Lock emptying with no powerhouse flow produced a rapid rise in water-surface elevation downstream of the powerhouse of about 2.4 ft. With three powerhouse units in operation, lock emptying produced a surge about the same as that with no powerhouse flow. There was little difference in the effects downstream of the powerhouse between Plans A and A-1. Start of three powerhouse units and lock emptying at the same time produced a rapid rise in water-surface elevations in the lock approach channel and in the reach downstream. Peak velocities were about 3 fps near the lock, 2.6 fps at the lower end of the lock approach channel (sta 3), and about 5.2 fps downstream (sta 4). Because of the rapid change in velocities, tows would experience serious difficulties in maintaining control particularly during the first 10 min after start of powerhouse releases and lock emptying.

Plan A-2

Description

44. Plan A-2 was developed during preliminary tests in an effort to

reduce the adverse effects on navigation approaching and leaving the lock downstream of the dam. The features of this plan were as follows (Figure 8).

a. Upper pool same as Plans A and A-1.

b. Lower reach same as the original design.

c. A 600-ft-long V-notch dike was added at the end of the island between the powerhouse tailrace and the lower lock approach channel with a crest elevation of 135.0 and V-notch invert elevation of 115.0 and side slopes of 1V on 1.5H.

Tests were conducted with constant flow and with variations in the timing of lock filling and start of powerhouse releases.

Results

45. Water-surface elevations shown in Table 2 indicate very little difference between Plans A-1 and A-2. Current directions and velocities shown in Plates 33 and 34 indicate maximum velocities across the entrance to the lock approach channel to be about 6.1 fps with the low tailwater and about 4.7 fps with the higher tailwater elevation. However, currents were generally straight and parallel to the bank lines. No navigation difficulties were indicated with a steady powerhouse flow of 27,000 cfs for tows having sufficient power to move against the high-velocity currents. Conditions at the entrance to the lock approach channel were better with Plan A-2 than those with the original design because of the improvement in the alignment of the currents and less tendency for an eddy to form in the entrance.

46. Lock emptying with no powerhouse flow. Emptying the lock in 8.5 min with no powerhouse flow (Plate 35) produced surges and velocities somewhat higher than the original design near the lock (sta 2), somewhat less near the entrance to the lock approach channel (sta 3), and about the same downstream (sta 4). Increasing the lock emptying time from 8.5 to 12 and 15 min would produce a small reduction in the height of the surge but a considerable decrease in the maximum velocity in the lock approach channel (Plates 36 and 37). Maximum velocities at the entrance to the lock approach channel were reduced from about 5.2 fps with the 8.5-min lock emptying time to 4.2 fps with the 12-min emptying time and to about 3.7 fps with the 15-min emptying time. With 8.5- and 12-min lock emptying times, navigation conditions in the lock approach channel would tend to be hazardous for about 10 min after start of lock emptying because of the rapid increase in velocities and adverse currents near the entrance. Also a second surge moving up the approach channel would tend to cause tows to be grounded on either bank depending on location of the tow.

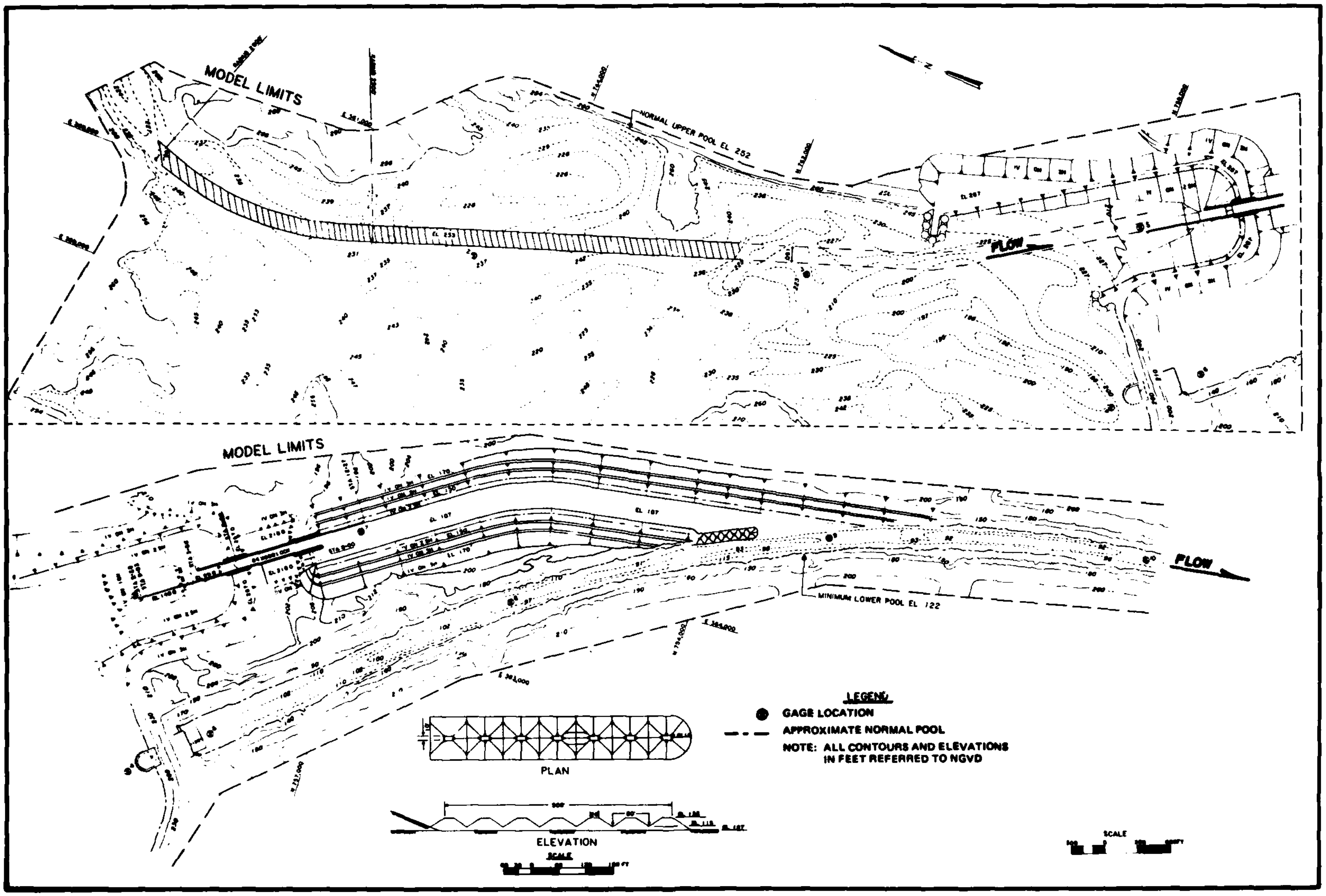

Figure 8. Bouldin Lock and Dam, Model A, Plan A-2

Conditions for navigation into and within the lock approach channel would be satisfactory in about 20 min after start of lock emptying. With the 15-min lock emptying time, conditions would be hazardous for navigation moving into and within the lock approach channel for about 10 min after start of emptying. With the longer emptying time, there would be a small second surge but the effects should not be sufficient to seriously affect navigation.

47. The effect of lock emptying on water-surface elevations near the powerhouse (sta 1) are shown in Plate 38. Increases in water-surface elevation were about 3.1, 2.8, and 2.3 ft for lock emptying times of 8.5, 12, and 15 min, respectively. Surges damped out faster with the increase in lock emptying time.

48. Start of powerhouse releases. Effects of starting three powerhouse units simultaneously on conditions in the lock approach are shown in Plate 39. These results indicate a rapid increase in water-surface elevation of 4.1 ft just below the lock (sta 2) and a more gradual increase near the entrance of about 4.0 ft. Upstream velocities increased from 0 to 3.2 and 2.8 fps for sta 3 and 2, respectively. Downstream of the lock approach channel, changes were more gradual than in the lock approach channel. Conditions were generally better in the lock approach channel than with the original design (Plate 13) because of the effect of the V-notch dike at the entrance that causes a reduction in the intensity of the surge and velocities and in the effects of the second surge. However, because of the sudden increase in velocities and adverse currents near the entrance to the lock approach channel, navigation conditions into and within the lock approach would tend to be hazardous for at least 10 min after the start of three powerhouse units simultaneously.

49. Start of powerhouse units at 10-min interval. Start of three powerhouse units at intervals of 10 min produced a considerable reduction in the magnitude of surge and changes in velocities in the lock approach channel (Plate 40). With the delay of at least 10 min in starting each succeeding unit, conditions were improved to the extent that no serious navigation difficulties were indicated during the operation.

50. Lock emptying with powerhouse start. Start of lock emptying with start of the first powerhouse unit and start of the second and third units at 10-min intervals caused a rapid increase in water-surface elevation and velocities within the lock approach channel (Plate 41). Navigation conditions for tows entering and within the lock approach channel would tend to be hazardous

for at least 10 min after start of lock emptying and the first powerhouse unit simultaneously. With this operation there would also be surges in water-surface elevations and velocities after the initial surge in the reach downstream (sta 4), but the changes would tend to be gradual and should not seriously affect navigation except for the first 10 min after start of the operation.

Plans B, B-1, B-2, and B-3

Description

51. The Plan B series was concerned with navigation conditions in the Walter Bouldin Reservoir and in the upper lock approach. For these tests, the minimum upper pool was established at el 248.0. Features of these plans were the same as those of Plans A and A-1 except for the following:

- a. Plan B. The bottom of the 220-ft-wide channel through the reservoir was raised from el 233.0 to el 239.0 (Figure 9).
- b. Plan B-1. Same as Plan B except that four dikes each 200 ft long were placed along the right side of the navigation channel and a dike 1,200 ft long was placed along the left side with top el 254.0 as shown in Figure 10. Side slopes of dikes were 1V on 1.5H.
- c. Plan B-2. Same as Plan B except that the bottom of the 220-ft-wide channel was lowered to el 235.0 and the approach to the lock was dredged to el 233.0 (Figure 11).
- d. Plan B-3. Same as Plan B-2 except that the dikes of Plan B-1 were added (Figure 12).

Results

52. Water-surface elevations obtained during these tests indicate little change except as affected by changes in the pool elevation (Table 3). Slopes through the reach were generally moderate except at the upper end of the reservoir channel with Plan B-1 and the lower pool elevation. The upper gage (No. 1) was affected by the dikes and shallow channel. With the deeper channel of Plan B-3, the dikes had only a small effect on water-surface elevation.

53. Plan B. Current directions and velocities shown in Plates 42 and 43 indicate maximum velocities out of the diversion canal to be about 6.2 fps with the lower pool and about 4.1 fps with the higher pool. Velocities were much lower after passing the bend in the upper reach of the reservoir channel. Current alignments were affected by flow out of and back into the dredged

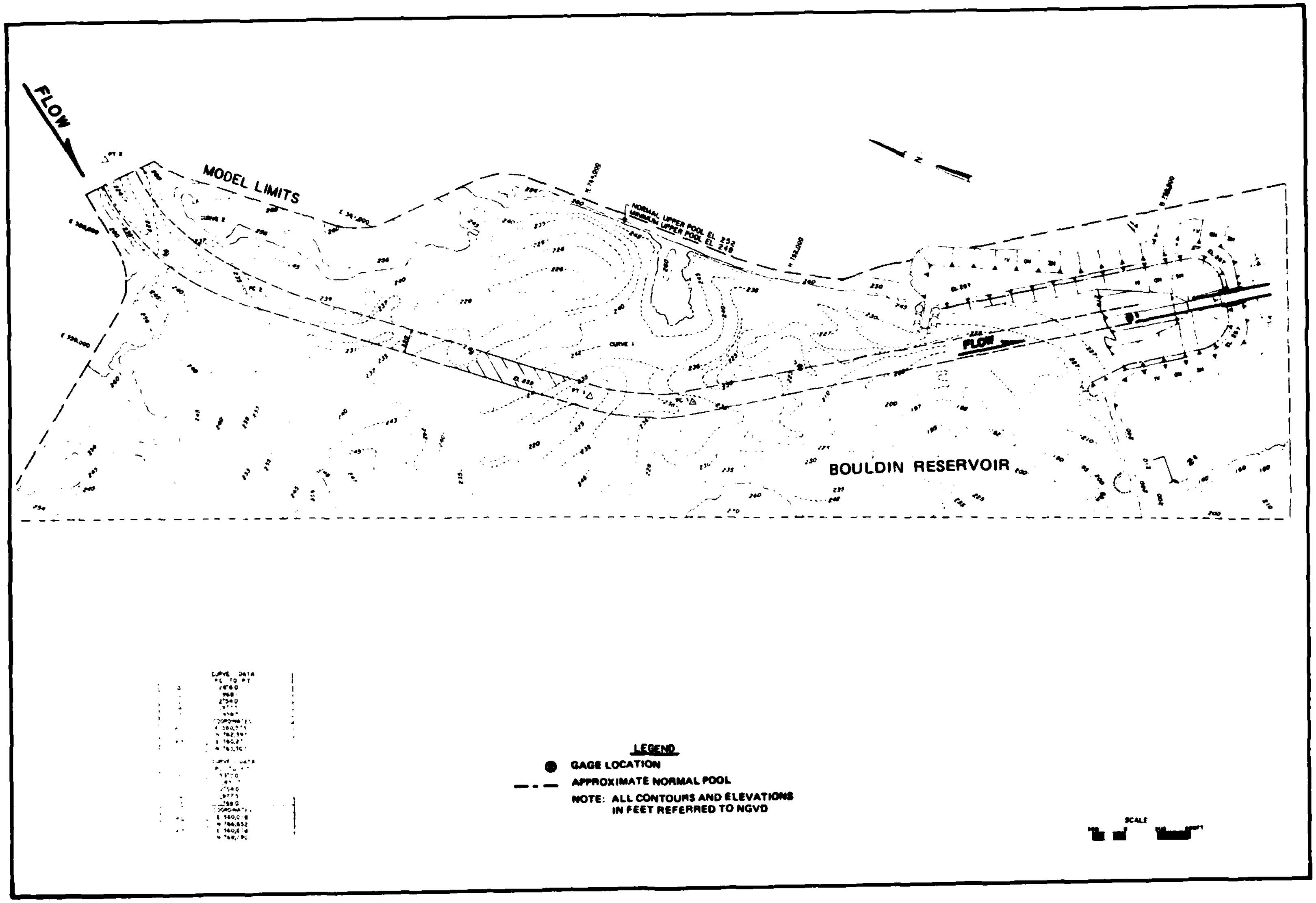

Figure 9. Bouldin Lock and Dam, Model A, Plan B

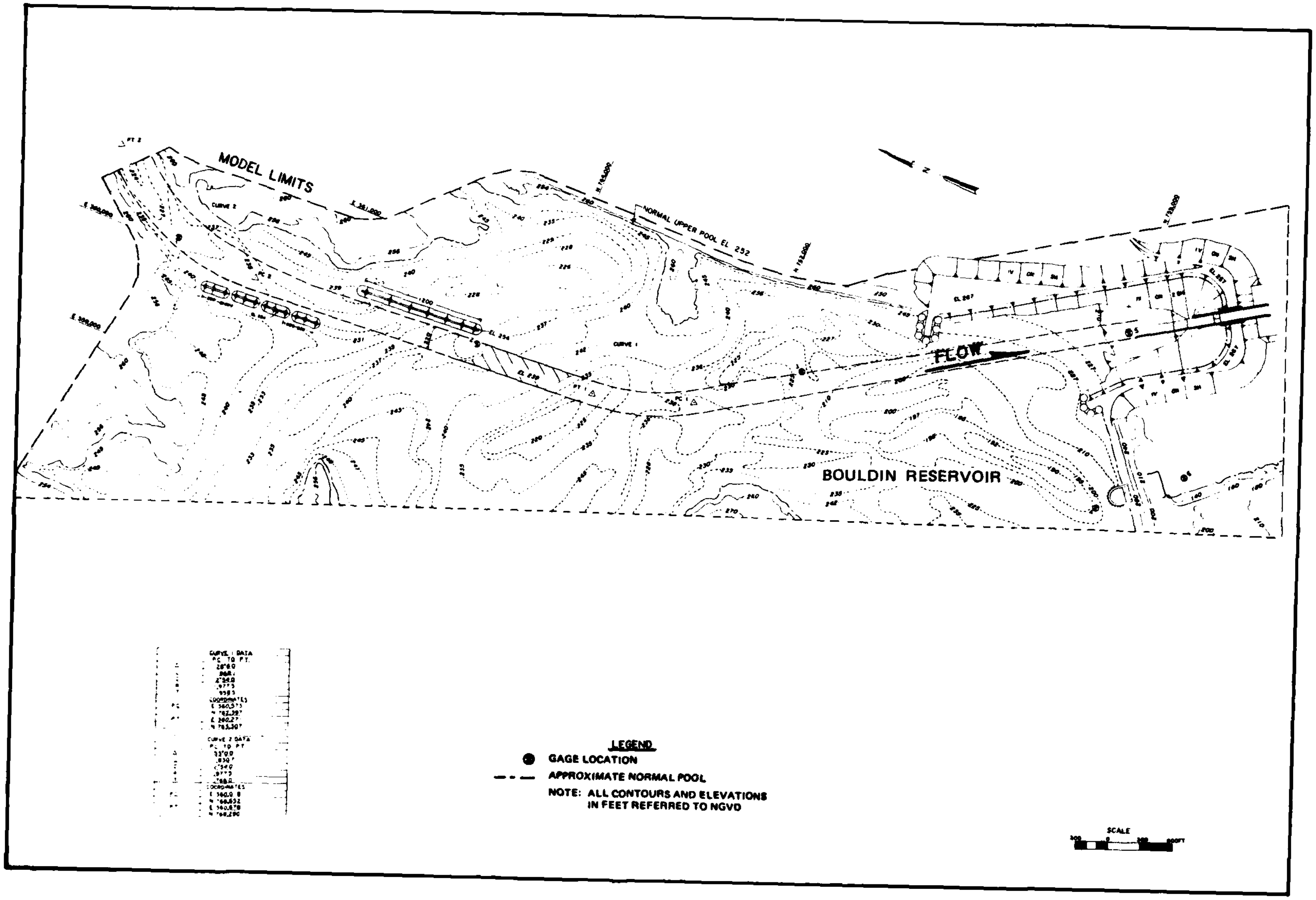

Figure 10. Bouldin Lock and Dam, Model A, Plan B-1

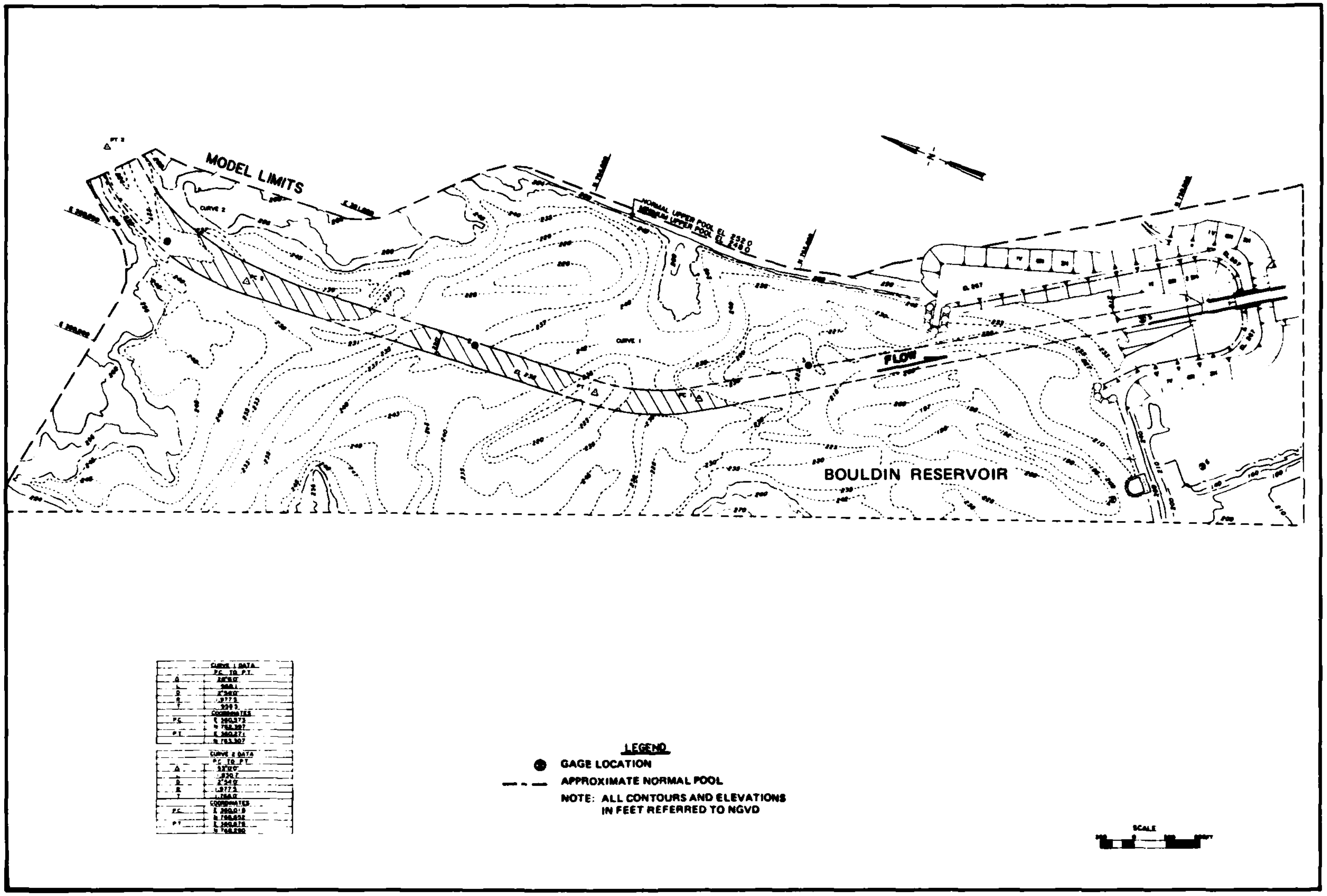

Figure 11. Bouldin Lock and Dam, Model A, Plan B-2

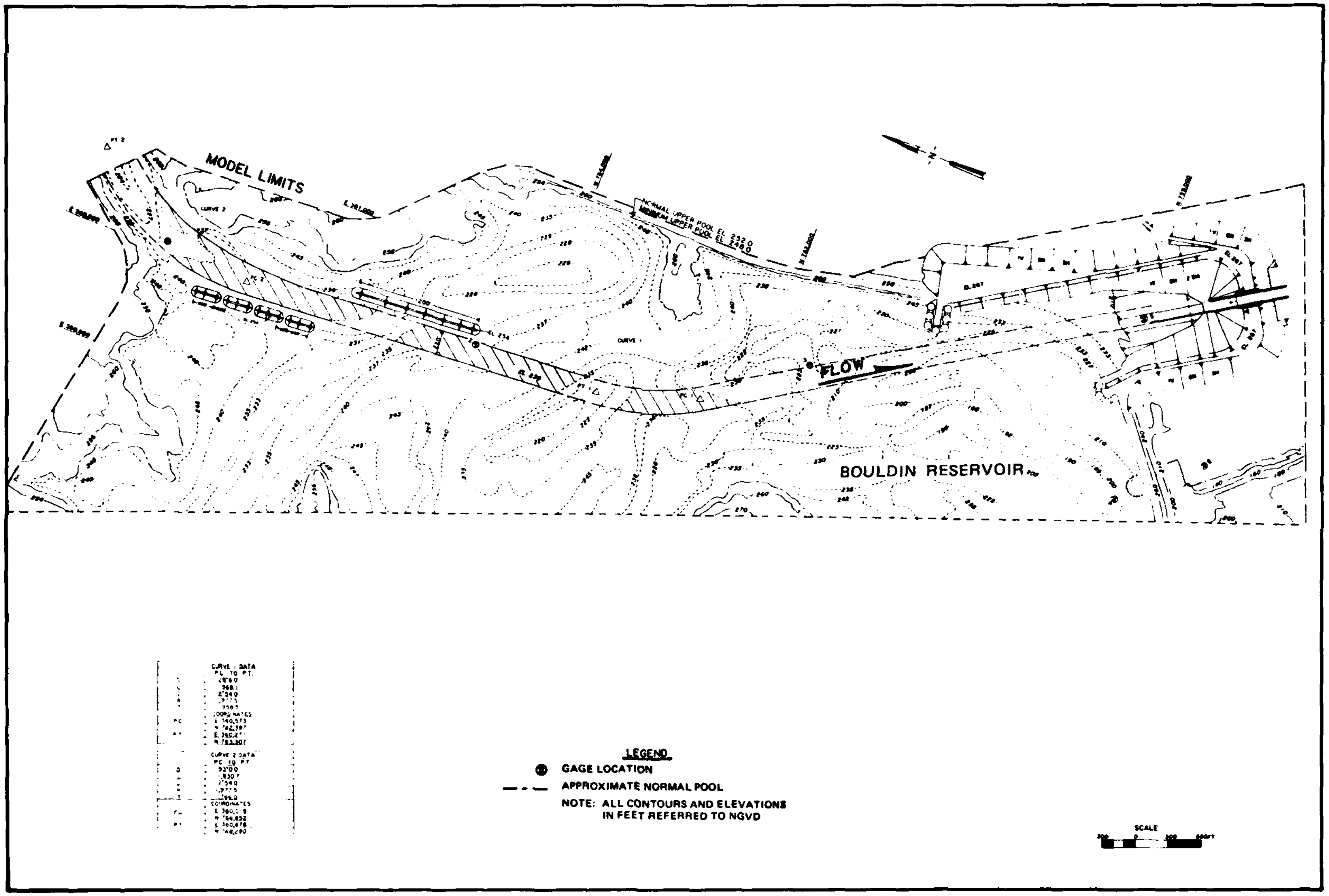

Figure 12. Bouldin Lock and Dam, Model A, Plan B-3

channel and by the large eddies formed along both sides. Navigation conditions for upbound and downbound tows were generally difficult and hazardous particularly with the lower pool. Tows would tend to be moved aground by currents moving out of the channel and by eddies and crosscurrents.

54. Plan B-1. Velocities just downstream of the end of the diversion canal were slightly higher than those with Plan B particularly along the right side of the bend in the reservoir channel (Plates 44 and 45). There was a considerable improvement in the alignment of the currents with respect to the channel alignment. With the lower pool, navigation conditions were affected to some extent by eddies downstream of the knoll extending into the reservoir upstream of the dam, but the effects could be overcome by tows with sufficient power and maneuverability without serious difficulties. No difficulties were indicated for navigation with the higher pool.

55. Plan B-2. Maximum velocities with the deeper channel of Plan B-2 were about the same as those with Plan B, but the alignment of the currents was considerably better with less flow moving out of the channel (Plates 46 and 47). Except for the effects of the eddy upstream of the knoll which could be easily overcome, no serious navigation difficulties were indicated particularly with the higher pool.

56. Plan B-3. The addition of the dikes of Plan B-1 had little effect on velocities near the upper end of the reservoir channel but generally increased velocities within the channel downstream (Plates 48 and 49). The alignment of currents was better than that with Plan B-1 or B-2 and no serious navigation difficulties were indicated with either the 248.0 or 252.0 pool.

PART IV: JORDAN RESERVOIR (MODEL B)

Description of Existing Conditions

57. This study was conducted to determine navigation conditions within the Jordan Reservoir and in the entrance to the dredged canal connecting the Jordan Reservoir to the Walter Bouldin Reservoir referred to as the diversion canal. The model for this test reproduced the essential features of the Jordan Reservoir and about 3,000 ft of the Jordan end of the diversion canal based on the latest available surveys (Figure 13).

Test Results

58. Results of tests with various flow conditions are included in Table 4. These results indicate very little slope in the reservoir with a drop of only about 0.1 ft from the center of the reservoir (gage 2) to the canal entrance (gage 3) with a flow of 27,000 cfs through the diversion canal with either pool. The drop through the entrance to the canal (gages 3 and 4) was about 0.3 to 0.4 ft with the 252.0 pool and about 0.4 to 0.6 ft with the lower pool, the drop increasing with increase in total discharge.

59. With a total flow of 27,000 cfs through the canal toward the Bouldin Reservoir and no flow through the Jordan Dam, current velocities in the reservoir were less than 1 fps and increased to about 4.2 fps in the entrance to the canal with the 248.0 pool elevation and to about 3.5 fps with the 252.0 pool elevation (Plates 50 and 51). Velocities in the upper reach of the canal reached a maximum of about 5.5 fps with the lower pool and about 4.3 fps with the higher pool.

60. With a flow of 175,000 cfs toward the Jordan Dam and no flow into the diversion canal, currents were reasonably straight with maximum velocities of about 2.3 fps with the 248.0 pool and about the same with the 252.0 pool (Plates 52 and 53). The higher velocities were along the left side of the reservoir away from the entrance to diversion canal. Except for a slow eddy that formed near the approach to the canal, there were no currents near the entrance. With a flow of 90,000 cfs toward the Jordan Dam and no flow in the canal, conditions were about the same as those with the 175,000-cfs flow except that velocities were lower with a maximum of about 1.2 fps with the 248.0 and 252.0 pools (Plates 54 and 55).

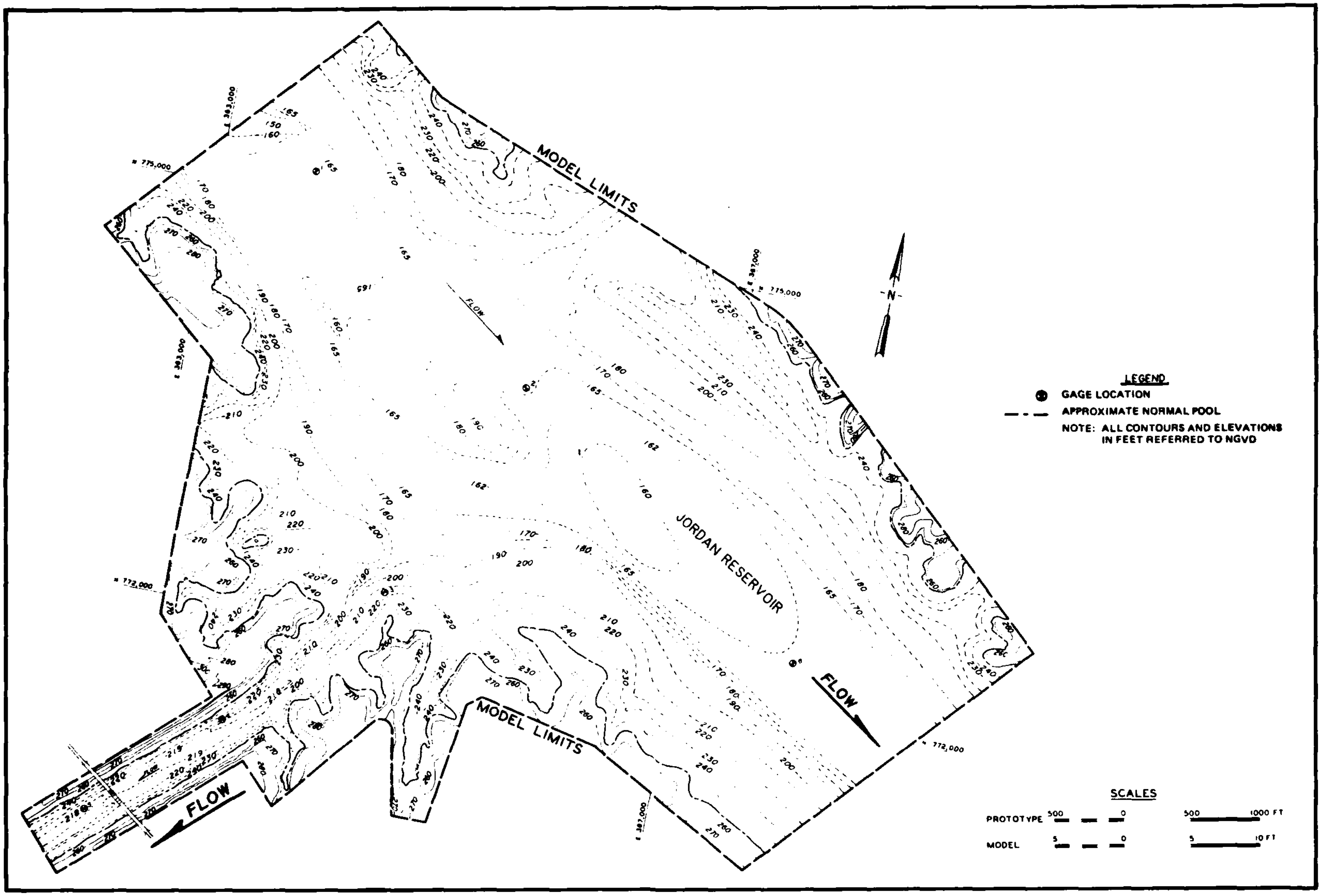

Figure 13. Jordan Reservoir, Model B, existing conditions

61. With a total flow 175,000 cfs of which 27,000 cfs was diverted through the diversion canal, velocities approaching the entrance were about 1.0 to 2.1 fps with 248.0 pool and increased to 4.4 fps in the entrance (Plate 56). With the 252.0 pool, the approach velocities were about 1.3 to 1.8 fps and increased to about 3.6 fps in the entrance (Plate 57). Maximum velocities downstream of the entrance to the canal were about 5.0 and 4.5 fps for the low and high pool, respectively.

62. With a total flow of 90,000 and 27,000 cfs through the canal, velocities and currents approaching and entering the canal were about the same as those with the 175,000-cfs flow (Plates 58 and 59).

63. No serious navigation difficulties were indicated through the Jordan Reservoir and in the approaches to the diversion canal with any of the flows tested.

PART V: CONFLUENCE OF BOULDIN POWERHOUSE TAILRACE AND ALABAMA RIVER

Existing Conditions

Description

64. Conditions existing in the vicinity of the confluence of the Walter Bouldin powerhouse tailrace and the Alabama River are shown in Figure 14. Tests were conducted to determine navigation conditions for tows entering and leaving the powerhouse tailrace under various conditions of flow in the river and from the tailrace. Surge tests for lock emptying and start of powerhouse releases were based on the conditions measured on the Bouldin Lock and Dam model and extended downstream based on the results of SOCHMJ* numerical models. Surge tests were conducted with a steady riverflow of 27,000 cfs past the tailrace channel entrance.

Results

65. Water-surface elevations shown in Table 5 indicate slopes to be generally moderate in the reach varying from about 0.4 ft/mile with low flows to about 0.64 ft/mile with the 155,000-cfs flow.

66. Current directions with flow from the tailrace of 27,000 cfs and no flow in the Alabama River were generally straight and parallel to the bank lines except for eddies that formed in the river channel at its junction with the tailrace channel (Plate 60). Velocities in the tailrace channel were as much as 6.2 fps and in the river channel as much as 5.2 fps. With a flow of 27,000 cfs in the Alabama River and no tailrace flow, currents moved across the entrance to the tailrace channel with a maximum velocity of about 6.7 fps (Plate 61). A clockwise eddy formed in the entrance to the tailrace channel with a maximum velocity of about 2.8 fps. Velocities across the entrance to the tailrace channel were affected by the bend in the river channel and by the eddy that formed on the convex side of the bend.

67. With a 60,000-cfs flow and no tailrace flow, velocities across the entrance to the tailrace channel were not as high as with the 27,000-cfs flow due principally to the higher tailwater elevation (11.8 ft). The eddy in the entrance to the tailrace channel was longer and extended farther upstream

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* Simulation of Open Channel Hydraulics in Multijunction Systems.

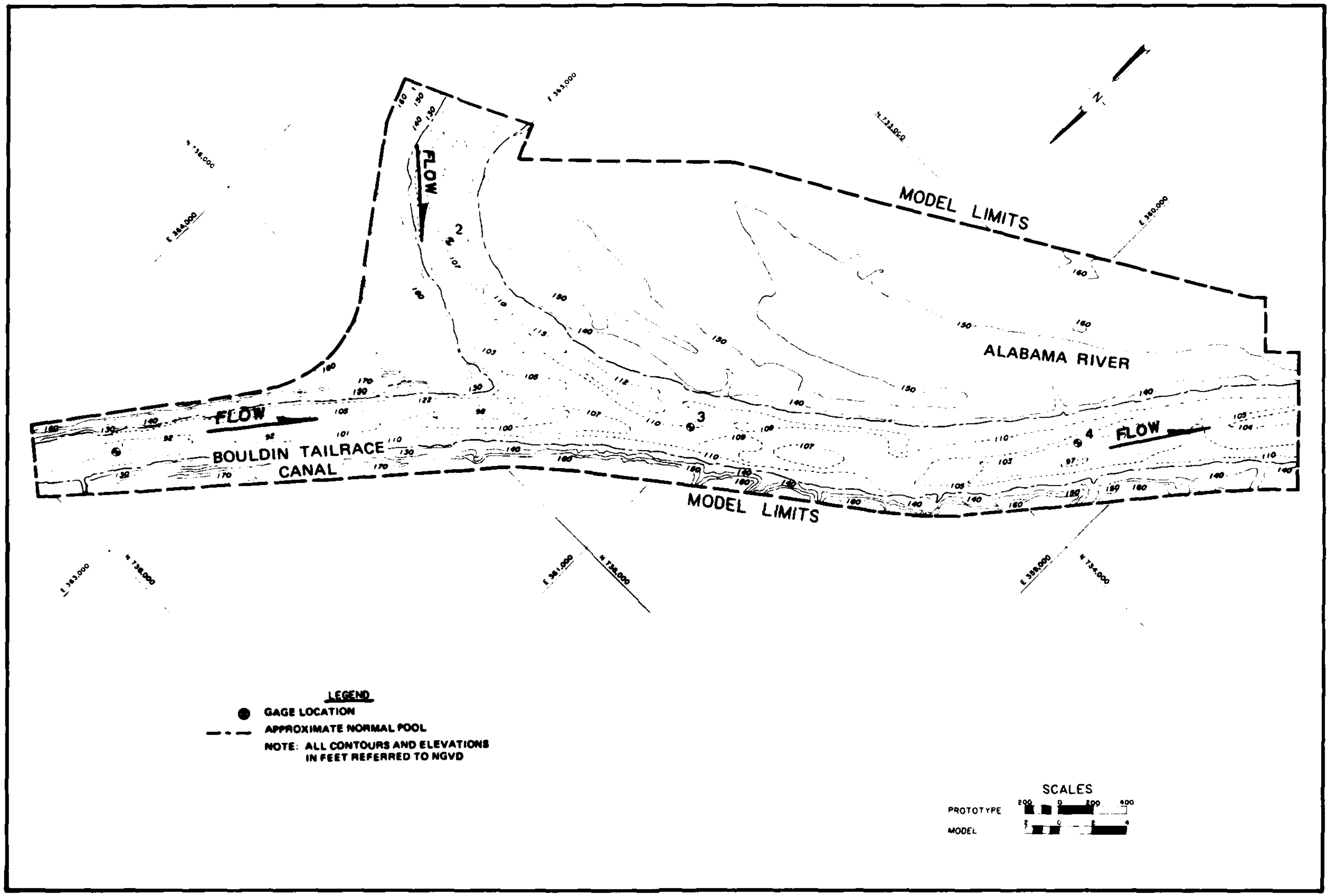

Figure 14. Bouldin tailrace confluence, Model C, existing conditions

(Plate 62). With a combination of 27,000-cfs flow from the tailrace and 63,000-cfs flow from the river upstream, maximum velocities in the tailrace channel were generally less than 3 fps and those in the river channel downstream were about 6.3 fps. The alignment of currents was reasonably parallel with the bank lines and no disturbance was indicated in the flow at the confluence of the tailrace and river channel (Plate 63). With a riverflow of 90,000 cfs and no tailrace flow, currents moved across the entrance to the tailrace channel with velocities of 4.2 to more than 5 fps (Plate 64). Velocities in the river channel downstream of the entrance were mostly between 6 and 7 fps. The usual clockwise eddy formed in the entrance to the tailrace channel. With a riverflow of 155,000 cfs and no powerhouse releases, velocities of currents across the tailrace entrance were more than 6 fps (Plate 65). Velocities in the reach downstream of the entrance were as high as 8.8 fps.

68. Lock emptying with no tailrace flow produced a surge of about 1.9 and 1.7 ft in the lower reach of the tailrace channel (sta 1-A and 2-A, respectively)* with maximum velocities of 3.4 and 3.9 fps (Plate 66). Downstream in the river channel (sta 3-A) surges were about 1.5 ft. Starting of three powerhouse units simultaneously produced a steady increase in water-surface elevation of about 3.3 ft initially in the lower reach of the tailrace channel with a more rapid increase in velocity up to about 4.3 fps (Plate 67). The increase in water-surface elevation in the river channel downstream was about 2.8 ft. Starting three powerhouse units and lock emptying at the same time produced an increase in water-surface elevation of about 4.4 ft in about 10 min with rapid increase in velocities up to about 6 fps in the lower reach of the tailrace channel (Plate 68). In the river channel downstream, the increase in water level was only slightly less than in the tailrace channel.

69. With a flow of 27,000 cfs in the Alabama River, emptying the lock in 8.5 min or starting three powerhouse units at the same time would produce surges and rapid increases in velocities that could be hazardous to navigation in the reach for about 10 min after the surge approaches the reach. Conditions would be much worse with start of three powerhouse units and lock emptying at the same time creating hazardous navigation conditions for at least 20 min after the surge approaches the reach. With flow in the Alabama River and no tailrace flow, navigation was affected by high-velocity currents across

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* Locations of surge stations are shown in Figure 15.

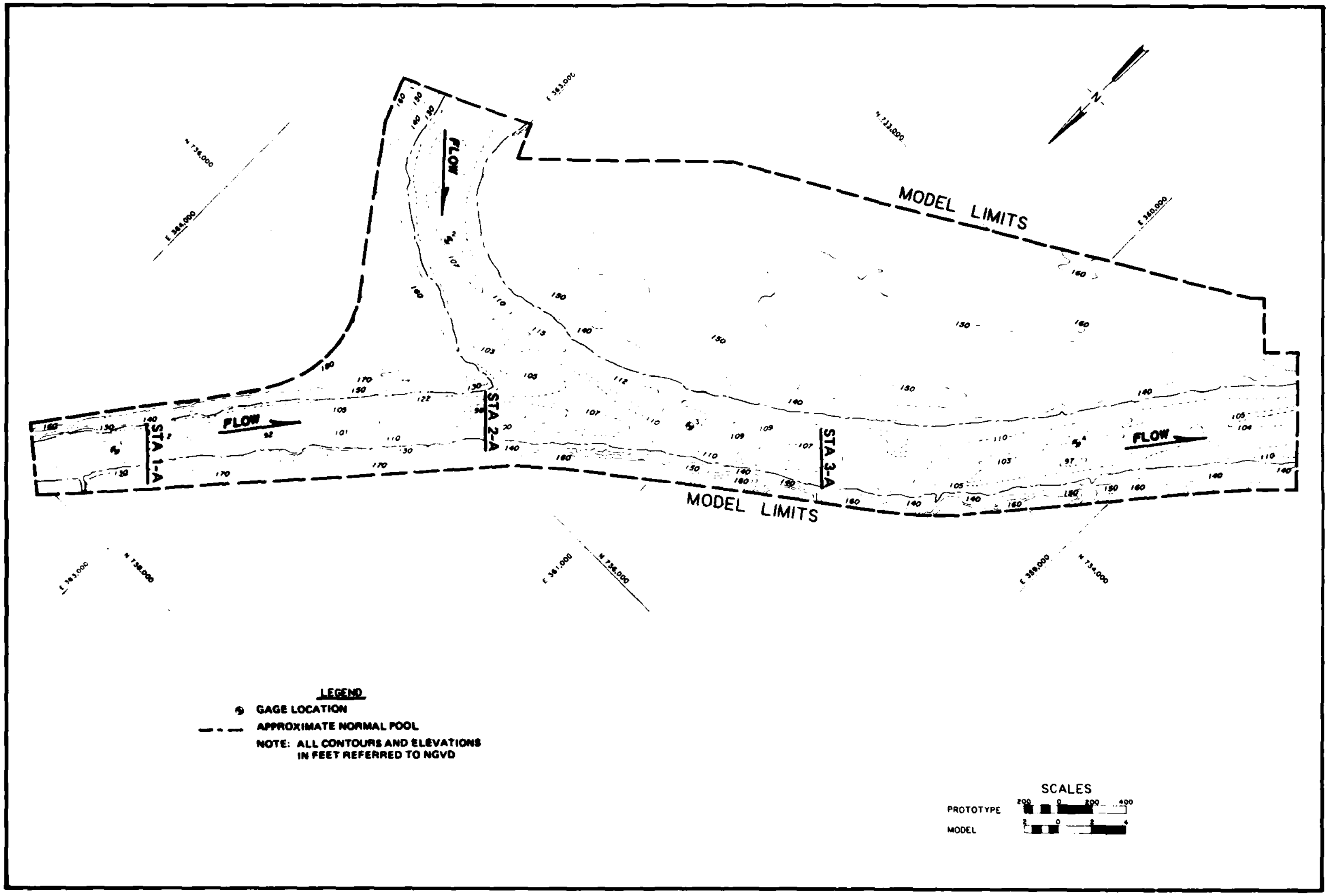


Figure 15. Bouldin tailrace confluence, Model C, surge stations

the tailrace entrance and a large eddy in the tailrace entrance. A tow entering or leaving the tailrace would tend to be pushed aground on the right bank.

Plan A

Description

70. Plan A was the same as existing conditions except for the installation of a training dike forming an extension of the point at the confluence of the Alabama River and Bouldin tailrace channel as shown in Figure 16. The 180-ft-long dike, with top el 160.0, was designed to improve the alignment of the currents across the entrance to the tailrace channel when there is no flow from the tailrace.

Results

71. The dike of Plan A had no effects on water-surface elevations with any of the flows tested which were the same as those shown in Table 5. The dike of Plan A had no effect on currents with flows from the tailrace as shown in Plates 69 and 70. With flow from the river channel upstream and no flow from the tailrace channel, the dike was effective in improving the alignment of the currents across the entrance to the tailrace channel and no serious navigation difficulties were indicated (Plates 71-74). Velocities were generally increased along the convex side of the bend opposite the dike and reduced across the tailrace entrance except off the end of the dike. The clockwise eddy in the tailrace entrance was longer than that with existing conditions with somewhat higher velocities.

72. Surges measured with Plan A for lock emptying and start of powerhouse releases shown in Plates 75-77 indicate no difference that could be attributed to the installation of the dike. The dike was designed to improve conditions at the confluence with flow from the Alabama River and would not be expected to have any significant effects on surges resulting from lock emptying and/or start of powerhouse releases. Therefore the effect of surges on navigation would be about the same with or without the short dike of Plan A.

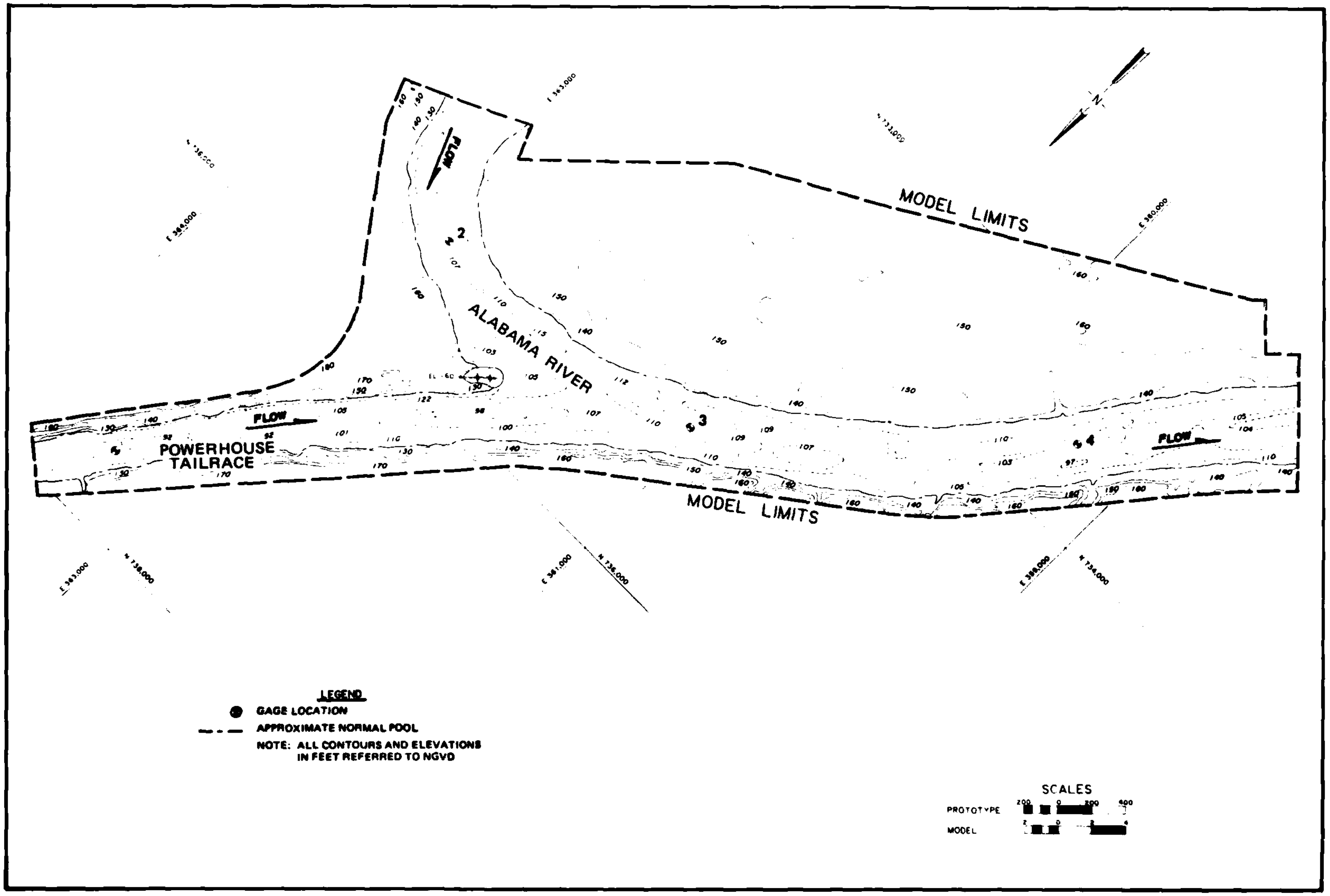


Figure 16. Bouldin tailrace confluence, Model C, Plan A

PART VI: SUMMARY AND CONCLUSIONS

Limitation of Model Results

73. Analysis of the results of this investigation is based principally on the effects of various plans and modifications on water-surface elevations, current directions, and velocities and the effects of the resulting currents on the behavior of the model towboat and tow. In evaluating test results, consideration should be given to the fact that small changes in direction of flow or in velocities are not necessarily changes produced by modification in plan since several floats introduced at the same point may follow a different path and move at slightly different velocities because of pulsating currents and eddies. Current directions and velocities shown in the plates were obtained with floats submerged to a depth of a loaded barge (9 ft prototype) and are indicative of the currents that would affect the behavior of tows.

74. The small scale of the model made it difficult to reproduce accurately the hydraulic characteristics of the prototype structures, measure small discharges, or measure water-surface elevations within an accuracy greater than ±0.1 ft prototype. Prototype data for model adjustment and for use in reproducing typical prototype operations were limited. The rate of lock filling and emptying was based on computed curves and the start of powerhouse releases was assumed to be instantaneous. Surges in the reach approaching the confluence of the Bouldin tailrace and Alabama River were based on computations with which the model was not entirely in agreement. It should also be noted that because of the lack of adequate prototype data, the tailwater elevation was modified for various tests. Effects of weather conditions were not considered in the evaluation of results. Also the effects of closing down the power units on navigation conditions were not determined.

75. In spite of the above limitations, the model provided a reasonably adequate indication of effects that can be expected based on the conditions imposed on the model.

Discussion of Results

Bouldin Lock and Dam

76. Navigation conditions through the Bouldin Reservoir would be

affected by flow from the diversion canal, the alignment of the channel within the reservoir, the alignment of the currents moving out of and back into the dredged channel, eddies formed on either side of the channel, as affected by the knoll extending into the reservoir upstream of the dam, and elevation of the upper pool.

77. Navigation conditions for tows approaching and leaving the lock in the upper pool would tend to be extremely hazardous within the reservoir channel with the original design and upper pool elevation of 242.0. Conditions would be better with the higher pools (el 245.0 and 252.0) but there would be a strong tendency for tows to be moved aground because of crosscurrents particularly with the 245.0 pool elevation.

78. With the realigned and wider channel of Plan A, currents would tend to be irregular with respect to the channel alignment and velocities would tend to be generally higher than with the original design particularly with the lower pool. Navigation conditions in the reach upstream of the lock would tend to be extremely hazardous with the lower pool but would improve with increase in pool elevation. No serious navigation difficulties were indicated with the 252.0 pool elevation and conditions with Plan A would tend to be better than with the original design, principally because of the wider channel.

79. Reduction of the depth of the dredged channel in the reservoir as in Plan B to el 239.0 would increase velocity and the tendency for flow to move out of and back into the dredged channel increasing crosscurrents. Because of the crosscurrents and eddies, navigation conditions would not be as good as with the deeper channel of Plan A.

80. Addition of training dikes along the banks of the upper reach of the dredged channel as in Plan B-1 would improve the alignment of currents and navigation conditions through the reservoir but the tow would still encounter some difficulty because of crosscurrents.

81. Increasing the depth of the channel as in Plan B-2 would improve the alignment of currents and provide better navigation conditions than with Plan B. Addition of the training dikes (Plan B-3) produced additional improvements in the alignment of currents and in navigation conditions through the reservoir. No serious navigation conditions were indicated with either Plan B-2 or B-3 and high pool.

82. No serious navigation conditions were indicated in the upper lock approach downstream of the cofferdam cells. Conditions in the approach could

be improved by removal of the cells extending from the left bank just upstream of the lock.

83. Lock filling would have no effect on navigation conditions in the upper pool with any of the plans and pool elevations tested.

84. Navigation conditions in the lower pool would be affected by high-velocity currents, currents from powerhouse releases moving across the entrance to the lower lock approach channel, and surges from lock emptying and start of powerhouse releases.

85. Lock emptying in 8.5 min with no powerhouse flow creates a rapid increase in velocity and water-surface elevation within the lower lock approach channel and downstream. With powerhouse flow, the magnitude of the surge would be somewhat less and its duration considerably less. Because of rapid change in velocities and irregular currents, navigation conditions would tend to be hazardous for about 30 min after start of lock emptying without powerhouse flow.

86. Effects of start of powerhouse release would depend on the number of units started simultaneously, increasing with the number of units started. Navigation conditions in the lower lock approach would tend to be hazardous for about 10 min after start of one powerhouse unit and about 35 min after start of three powerhouse units, simultaneously. Start of powerhouse units at intervals of at least 10 min along with the V-notched dike in Plan A-2 would reduce the magnitude of surge and change in velocity to the extent that navigation would not be seriously affected.

87. Start of lock emptying and three powerhouse units at the same time would create hazardous navigation conditions in the lower lock approach for about 20 min after start of the operation. Start of lock emptying and one powerhouse unit simultaneously with the second and third units started at 10-min intervals would cause a rapid increase in water-surface elevations and velocities that would be hazardous for navigation for about 10 min after start of the operation.

88. Surges and rapid changes in velocities would tend to affect navigation for a considerable distance downstream of the entrance to the lower lock approach channel. The effect would tend to be less than in the lock approach channel and decrease with distance downstream.

89. Increasing lock emptying time would tend to reduce the magnitude and duration of the surge with some decrease in maximum velocities. Maximum

velocities with no powerhouse flow would be about 5.2 fps with 8.5-min emptying time. Conditions would tend to be hazardous for navigation for at least 20 min after start of 8.5- and 12-min emptying time and about 10 min after the start of the 15-min emptying time.

90. Increase in the tailwater elevation in the lower pool would tend to reduce surges and velocities in the lower lock approach.

91. Effects of surges on navigation conditions could be reduced with a canal across the island between the powerhouse tailrace and lower lock approach channel as in Plans A and A-1. Generally, conditions would be better with the smaller canal of Plan A-1 than with Plan A. Navigation conditions particularly near the entrance to the lock approach channel could also be improved with a notched dike at the end of the island between the tailrace and approach channel when used in conjunction with a 15-min lock emptying time or a 10-min start-up interval between powerhouse units as in Plan A-2.

Jordan Reservoir

92. No serious navigation difficulties were indicated within the Jordan Reservoir and for tows entering or leaving the upper end of the diversion canal whether or not there is flow in the canal. However, navigation conditions could be affected by weather conditions particularly with high winds and empty barges.

Confluence of Alabama River and Bouldin tailrace

93. No serious navigation difficulties were indicated for tows entering or leaving the tailrace with steady flow in the Alabama River and from the tailrace. With no flow from the tailrace and steady flow in the river, conditions would be better with a short dike at the confluence as in Plan A.

94. With no flow in the powerhouse tailrace and 27,000 cfs in the Alabama River, lock emptying or simultaneous start of three powerhouse units could create hazardous conditions in the lower reach of the tailrace and a short distance downstream that could last at least 10 min. Start of lock emptying and three powerhouse units could create rapid increase in water-surface elevations and velocities that could be hazardous for at least 20 min after the surge approaches the reach.

Conclusions

95. Navigation conditions in the reach including the Jordan Reservoir,

the diversion canal, Bouldin Reservoir, and Bouldin tailrace to below its confluence with the Alabama River will depend on many interrelated factors that could adversely affect the safe and efficient movement of tows. Results of this study are summarized as follows:

- a. No serious navigation difficulties should be experienced through the Jordan Reservoir and in the entrance to the diversion canal.
- b. Because of high velocities and crosscurrents, navigation conditions could be hazardous through the Bouldin Reservoir when the pool is below el 248.0 even with a 220-ft-wide channel and bottom at el 233.0. No serious navigation difficulties were indicated with a pool at el 252.0 and a 220-ft-wide channel.
- c. With a steady powerhouse flow of 27,000 cfs and low tailwater, tows with sufficient power to overcome the high-velocity currents could negotiate the powerhouse tailrace and lower lock approach channel without serious difficulty. However, lock emptying and start of powerhouse units would create surges that would be hazardous to navigation within the lock approach channel and in the reach downstream to below the confluence of the tailrace and the Alabama River, particularly with low tailwater.
- d. Hazardous conditions in the lower reach below the lock could be reduced to about 10 min after approach of the surge by increasing lock emptying time to at least 15 min and start of Bouldin powerhouse units at intervals of at least 10 min or by maintaining a high tailwater elevation.

Table 1

Walter Bouldin Lock and Dam, Original Design

Water-Surface Elevations, ft NGVD

Gage No.	Discharge in 1,000 cfs					
	18	18	18	27	27	27
1	244.6	245.6	252.1	245.3	246.1	252.2
2	243.8	245.3	252.1	244.2	245.4	252.2
3	242.0	245.1	252.0	242.2	245.2	252.1
4	242.0*	245.0*	252.0*	242.0*	245.0*	252.0*
5	242.0	245.0	252.0	242.0	245.0	252.0
6	125.0	125.0	125.0	125.4	125.4	125.4
7	125.0	125.0	125.0	124.9	124.9	124.9
8	125.0*	125.0*	125.0*	125.0*	125.0*	125.0*
9	124.9	124.9	124.9	124.9	124.9	124.9
10	124.4	124.4	124.4	124.0	124.0	124.0

Note: Gage locations shown in Figure 3.
* Controlled elevation.

Table 2

Walter Bouldin Lock and Dam, Plans A, A-1, and A-2

Water-Surface Elevations, ft NGVD

Discharge = 27,000 cfs

Gage No.	Plan A				Plan A-1	Plan A-2
1	245.6	246.3	252.2	252.2	252.2	252.2
2	244.5	245.7	252.1	252.1	252.1	252.1
3	242.0	245.0	252.0	252.0	252.0	252.0
4	242.0*	245.0*	252.0*	252.0*	252.0*	252.0*
5	242.0	245.0	252.0	252.0	252.0	252.0
6	125.2	125.2	125.2	131.0	125.2	125.3
7	125.1	125.1	125.1	131.0	125.1	124.9
8	125.0	125.0	125.0	131.0*	125.0	125.0
9	124.9	124.9	124.9	130.8	125.0	124.9
10	124.0*	124.0*	124.0*	130.4	124.0*	124.0*

Note: Gage locations shown in Figure 3.
* Controlled elevation.

Table 3

Walter Bouldin Lock and Dam, Plans B, B-1, B-2, and B-3

Water-Surface Elevations, ft NGVD

Discharge = 27,000 cfs

Gage No.	Plan B		Plan B-1		Plan B-2		Plan B-3	
1	248.4	252.2	249.0	252.2	248.3	252.2	248.5	252.2
2	248.1	252.1	248.2	252.1	248.1	252.1	248.1	252.1
3	248.0	252.0	248.1	252.1	248.0	252.0	248.0	252.0
4	248.0*	252.0*	248.0*	252.0*	248.0*	252.0*	248.0*	252.0*
5	248.0	252.0	248.0	252.0	248.0	252.0	248.0	252.0
6	125.4	125.4	125.4	125.4	125.4	125.4	125.4	125.4
7	124.9	124.9	124.9	124.9	124.9	124.9	124.9	124.9
8	125.0	125.0	125.0	125.0	125.0	125.0	125.0	125.0
9	124.9	124.9	124.9	124.9	124.9	124.9	124.9	124.9
10	124.0*	124.0*	124.0*	124.0*	124.0*	124.0*	124.0*	124.0*

* Controlled elevation.

Table 4

Jordan Reservoir, Existing Conditions

Water-Surface Elevations, ft NGVD

Gage No.	Discharge in 1,000 cfs 27*	90	90*	175	175*
1	252.0	252.1	252.1	252.2	252.2
2	252.0	252.1	252.1	252.1	252.2
3	251.9	252.0	252.1	252.1	252.1
4	251.6	252.0	251.7	252.0	251.7
5	251.6	252.0	251.7	252.0	251.7
6	252.0**	252.0**	252.0**	252.0**	252.0**
1	248.1	248.1	248.1	248.2	248.2
2	248.0	248.0	248.0	248.2	248.2
3	248.0	248.0	248.0	248.2	248.1
4	247.6	248.0	247.5	248.1	247.5
5	247.5	248.0	247.5	248.1	247.5
6	248.0†	248.0†	248.0†	248.0†	248.5†

* 27,000-cfs flow from Walter Bouldin Canal.
** Controlled elevation, normal upper pool.
† Controlled elevation, mimimum upper pool.

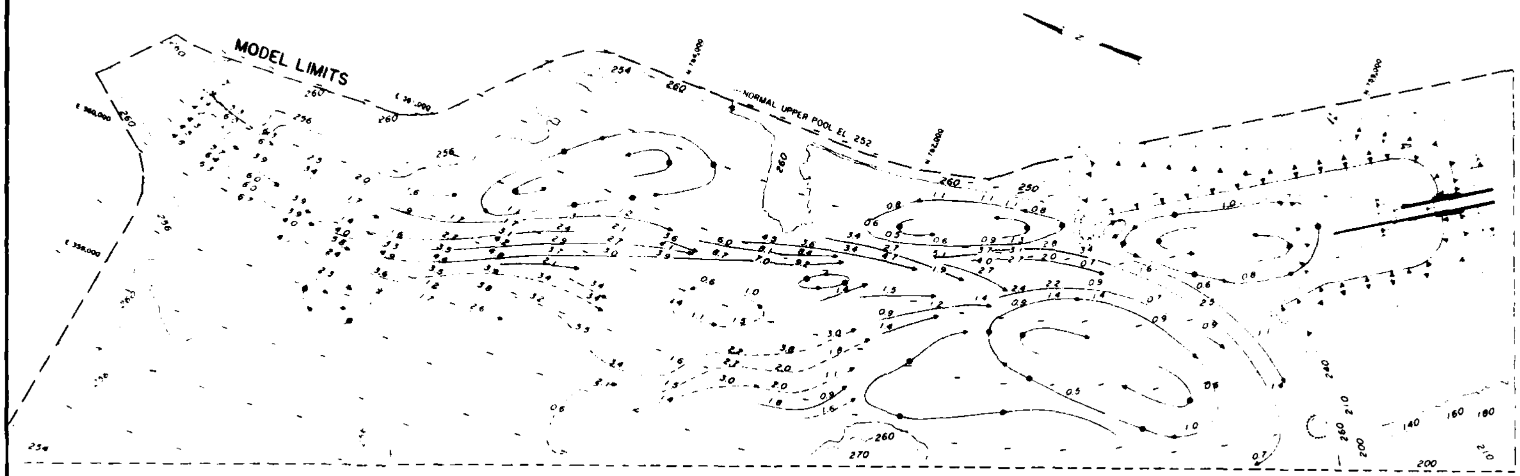
Table 5

Alabama River and Bouldin Tailrace Confluence, Existing Conditions

Water-Surface Elevations, ft NGVD

Gage No.	Discharge in 1,000 cfs 27	27*	60	90	90*	155
1	125.7	125.7	137.7	147.7	147.7	157.5
2	125.5	125.7	137.6	147.7	147.6	157.3
3	125.5**	125.5**	137.2**	147.2**	147.2**	157.0**
4	124.3	125.3	137.1	147.1	147.1	156.8

Note: Gage locations shown in Figure 14.
* 27,000-cfs flow from Walter Bouldin Powerhouse.
** Controlled elevation.



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED 6.0 FT

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

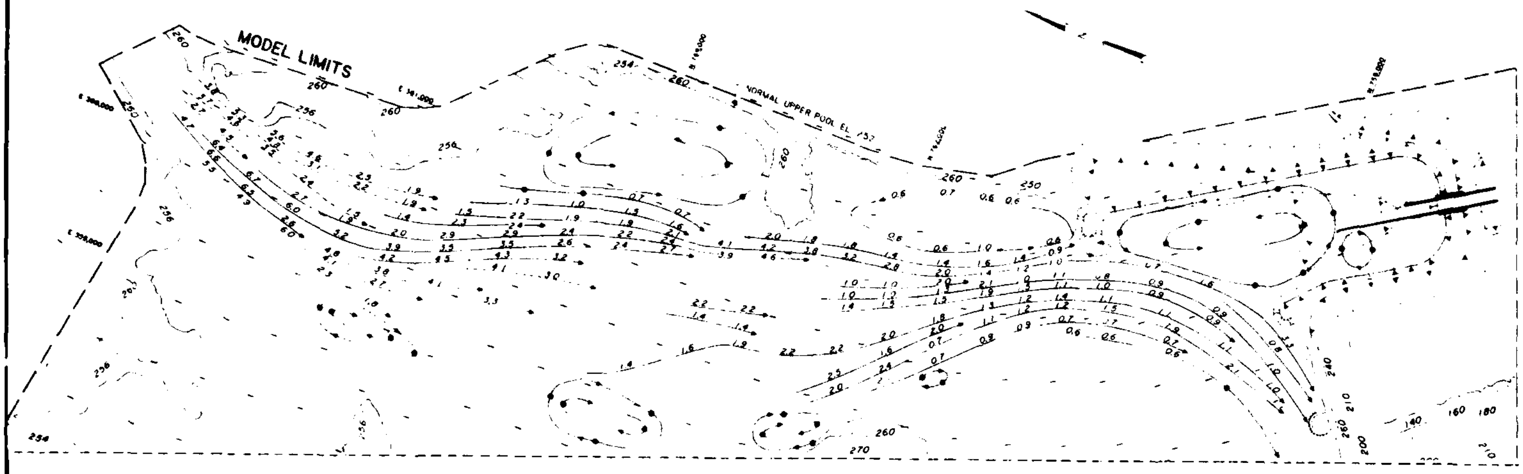
ORIGINAL DESIGN

DISCHARGE 18,000 CFS
UPPER POOL EL 242.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 1



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED 6.0 FT

NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

DISCHARGE 18,000 CFS
UPPER POOL EL 245.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 2

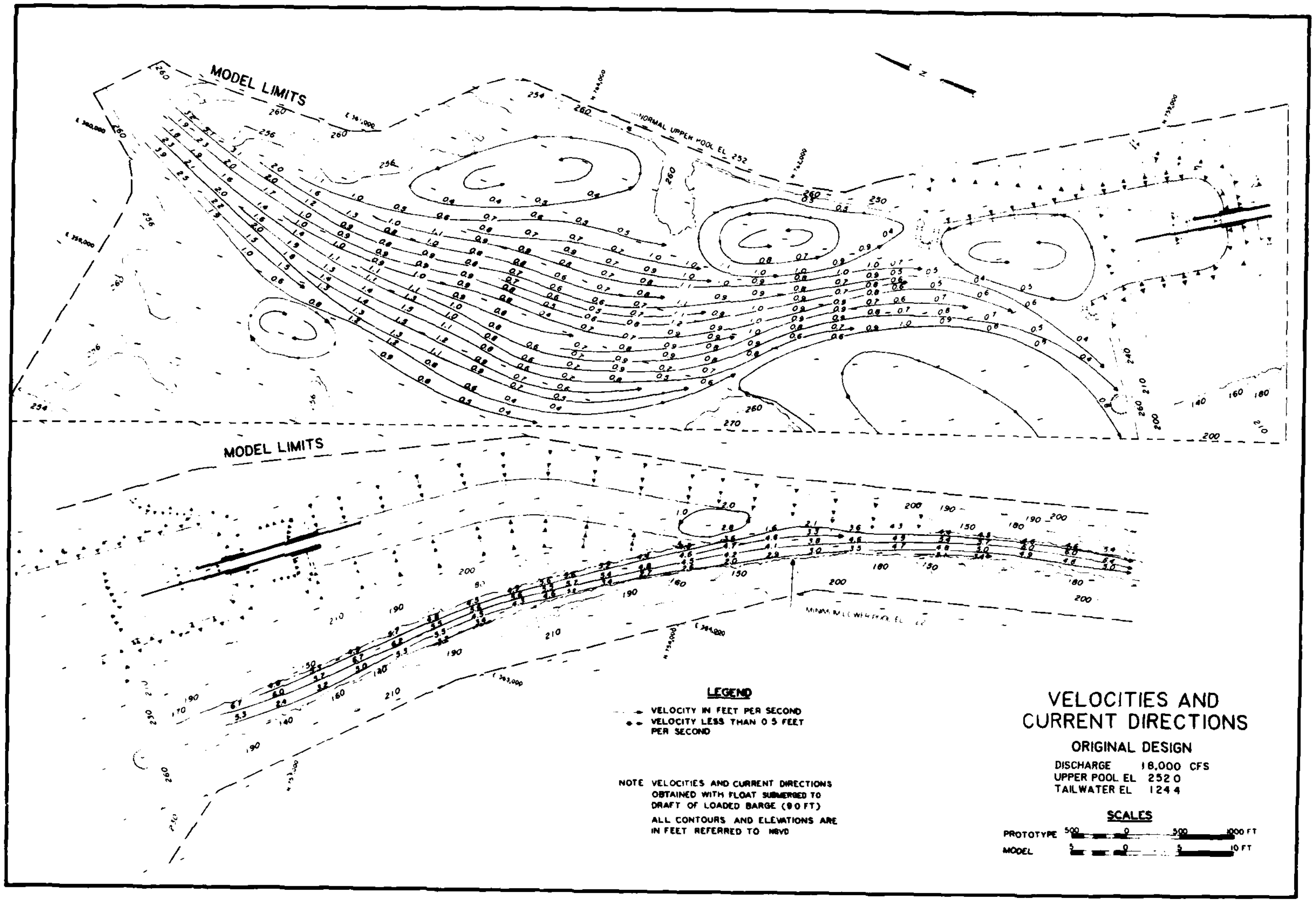

MODEL LIMITS
NORMAL UPPER POOL EL 252
MODEL LIMITS
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
VELOCITIES AND CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE 18,000 CFS
UPPER POOL EL 252.0
TAILWATER EL 124.4
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 3

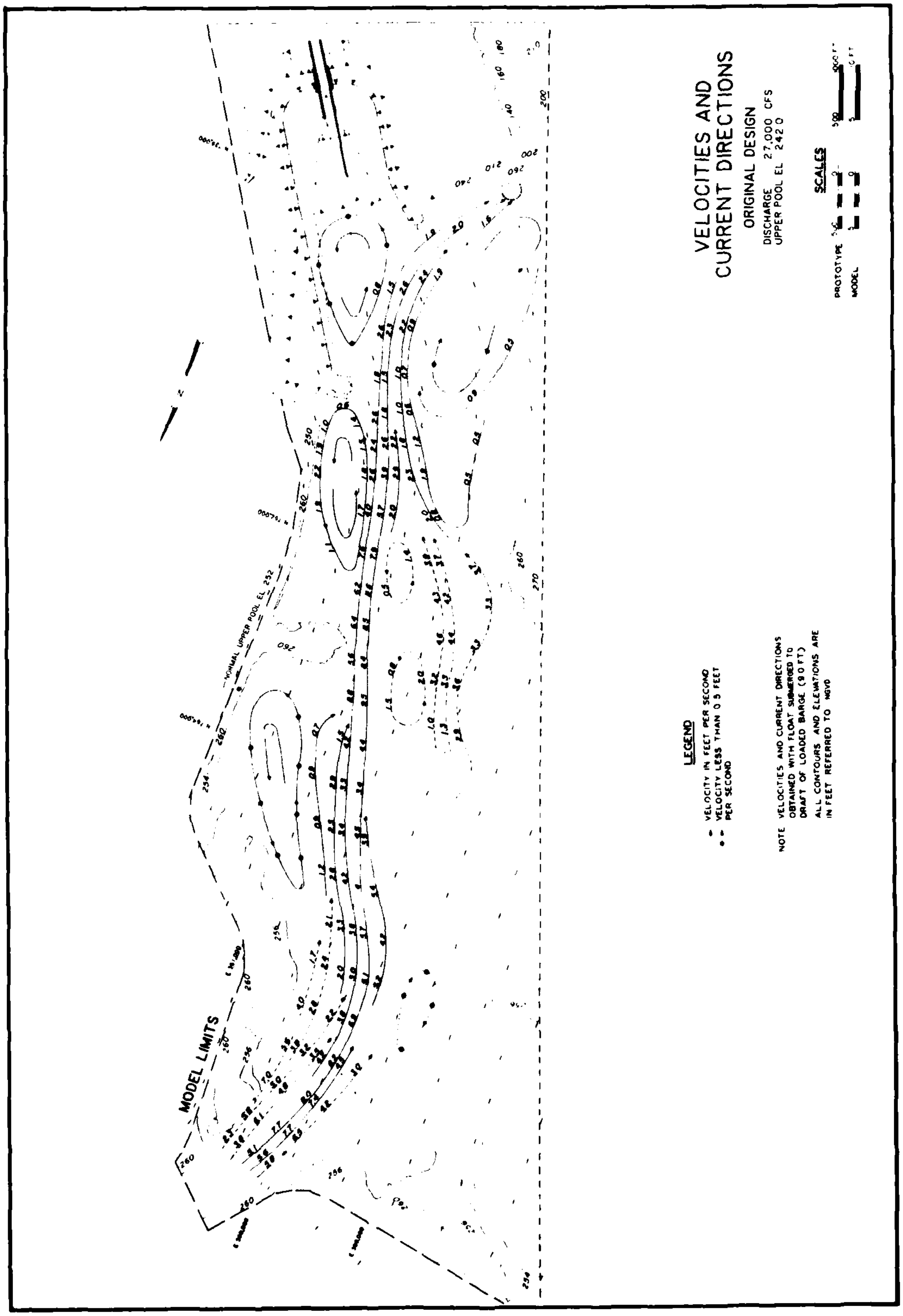
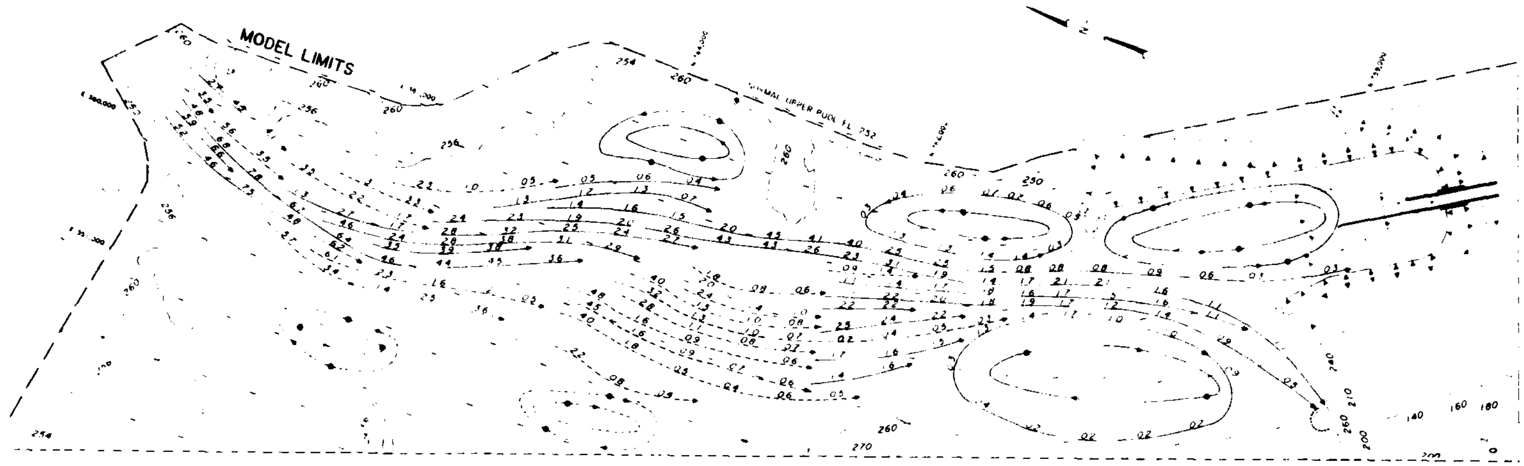

VELOCITIES AND
CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE 27,000 CFS
UPPER POOL EL 242.0
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
NORMAL UPPER POOL EL 252

PLATE 4



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED 6.0 FT

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

DISCHARGE 27,000 CFS
UPPER POOL EL 245.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

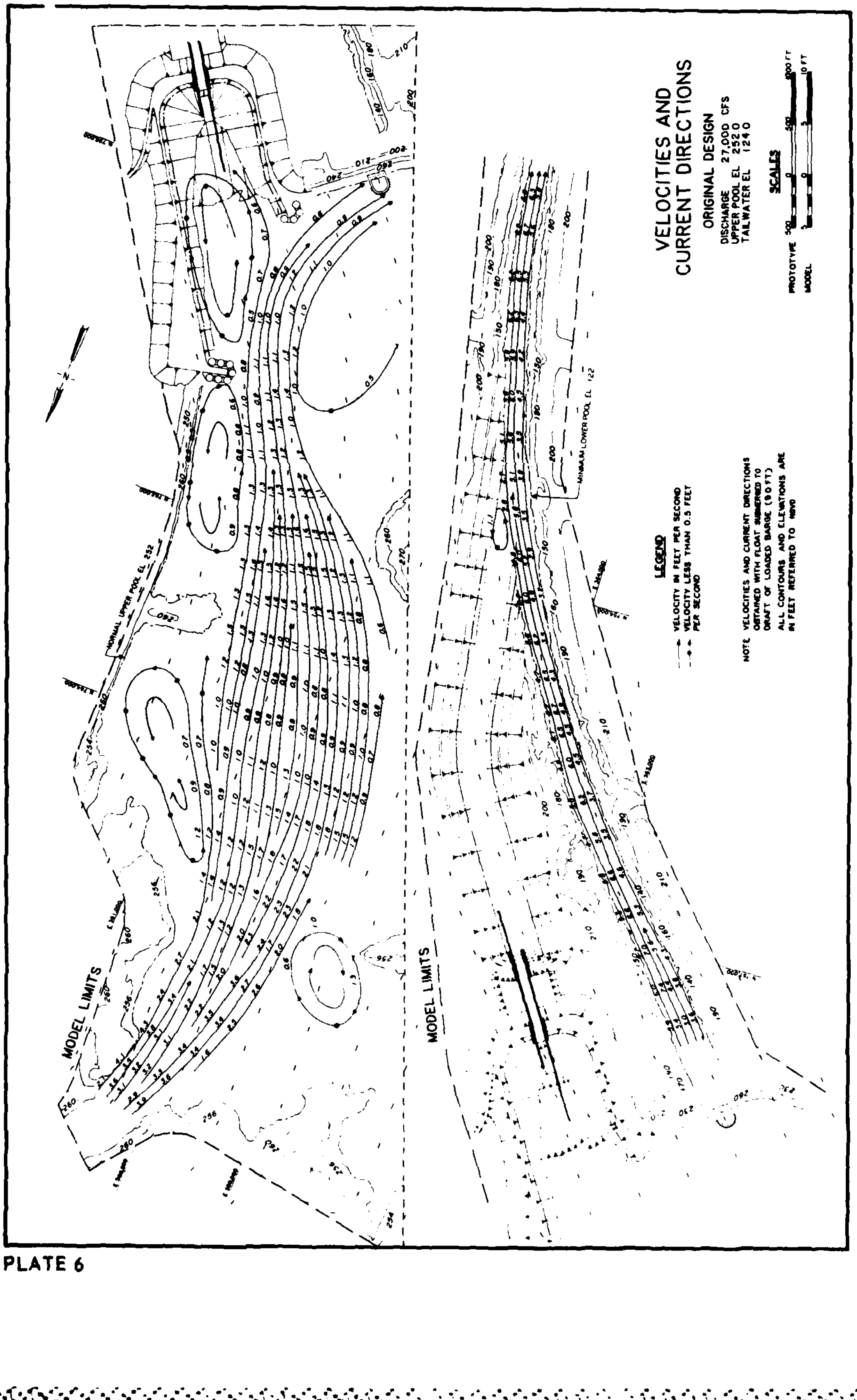
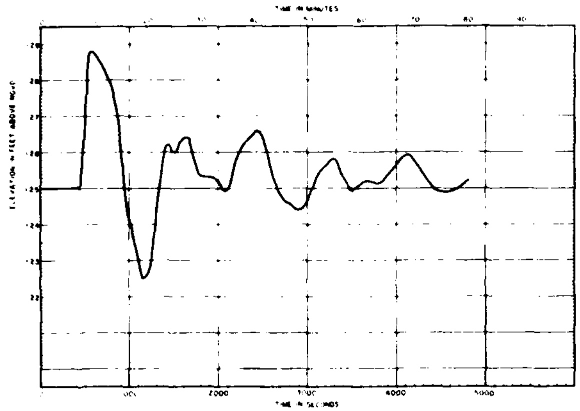
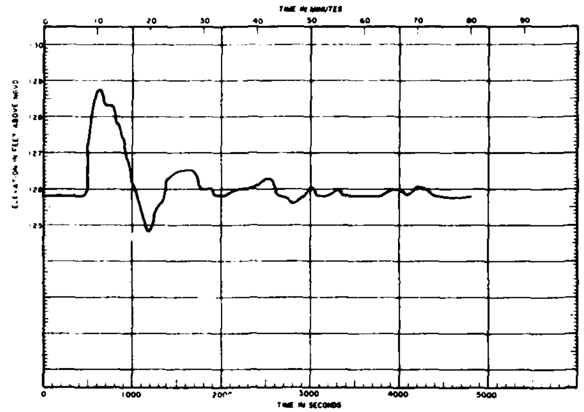

VELOCITIES AND CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE 27,000 CFS
UPPER POOL EL 252.0
TAILWATER EL 124.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
NORMAL UPPER POOL EL 252
MINIMUM LOWER POOL EL 122

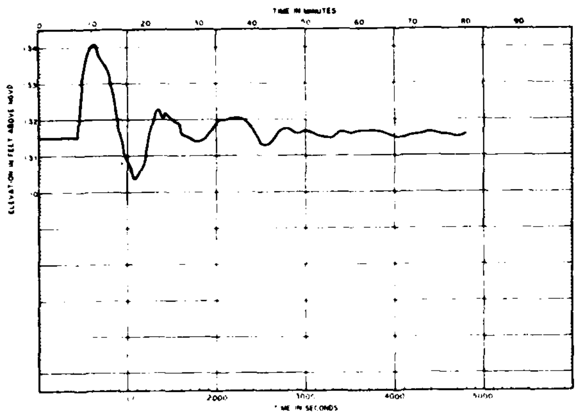
PLATE 6



POWERHOUSE DISCHARGE -0- CFS
INITIAL TAILWATER 125.0



POWERHOUSE DISCHARGE 27,000 CFS
INITIAL TAILWATER 125.4



POWERHOUSE DISCHARGE 27,000 CFS
INITIAL TAILWATER 131.0

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

LEGEND

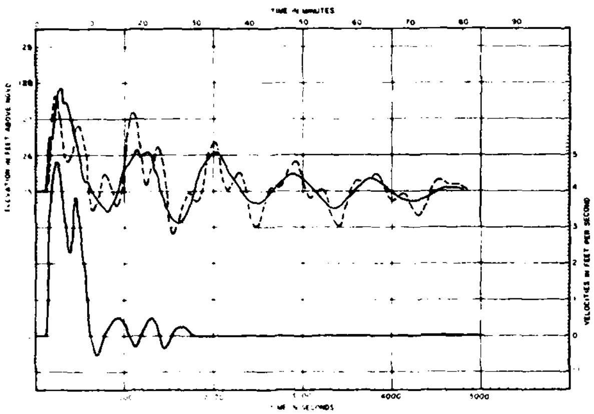
— MODEL DATA

SURGES AT STATION I

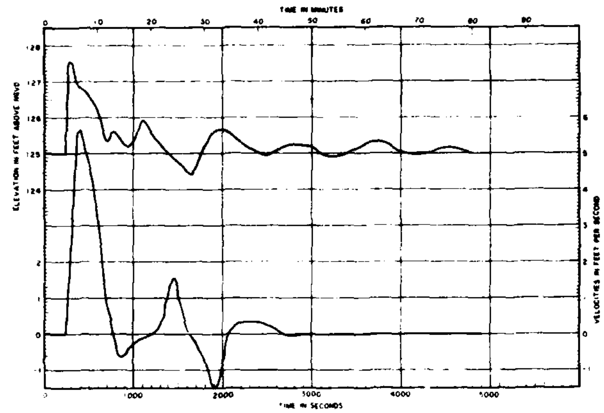
ORIGINAL DESIGN

LOCK EMPTYING TIME 8.5 MIN
UPPER POOL EL 252.2

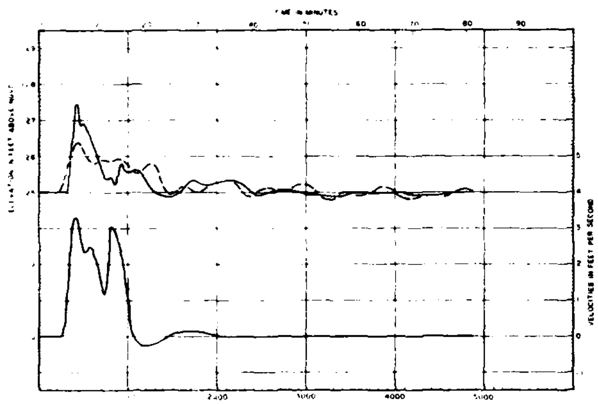
PLATE 7



STATION 2



STATION 3



STATION 4

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

LEGEND

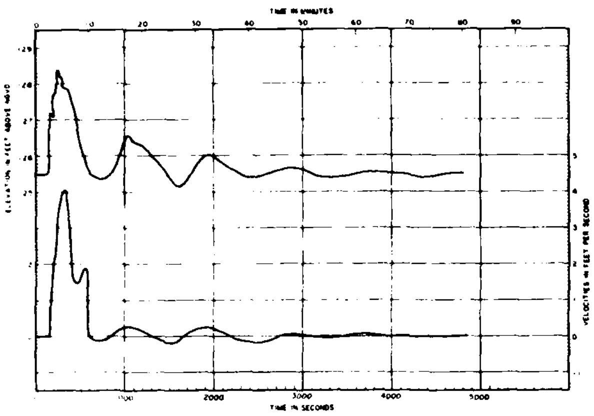
—— MODEL DATA

- - - COMPUTED DATA

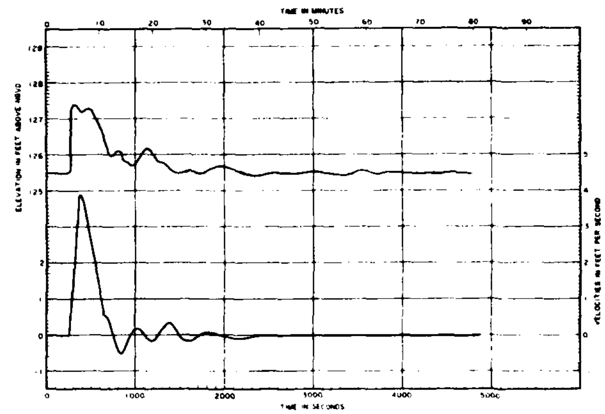
VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0 CFS
LOCK EMPTYING TIME	8.5 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



STATION 8



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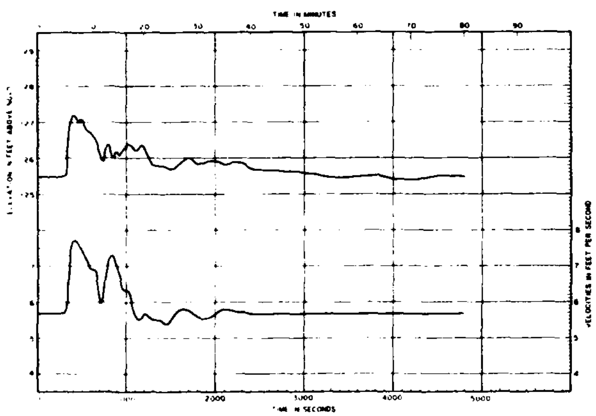


STATION 13

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

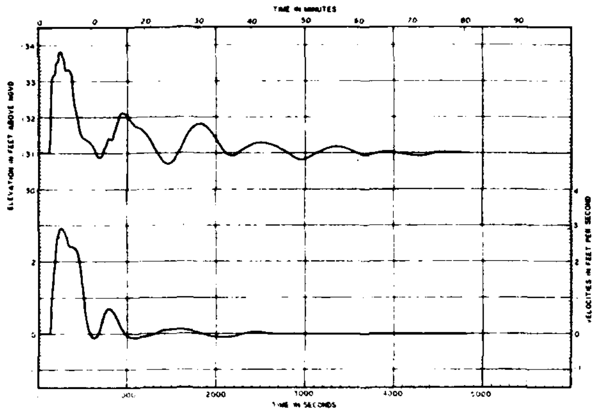
LEGEND

— MODEL DATA

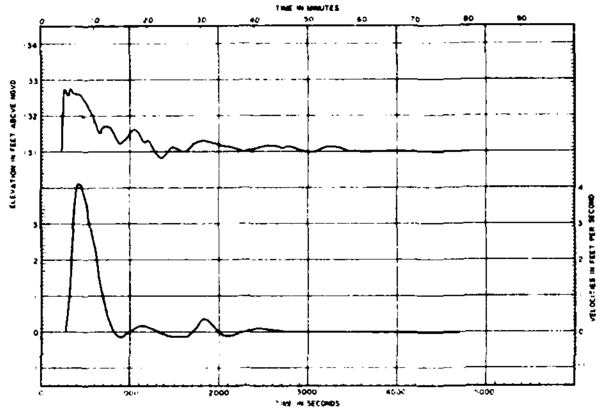
VELOCITIES AND SURGES

ORIGINAL DESIGN

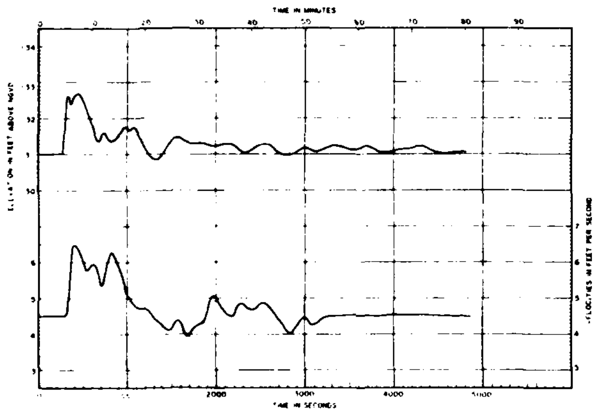
LOCK EMPTYING TIME	8.5 MIN
POWERHOUSE DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	125.4
UPPER POOL EL	252.0



STATION 8



STATION 11



STATION 13

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

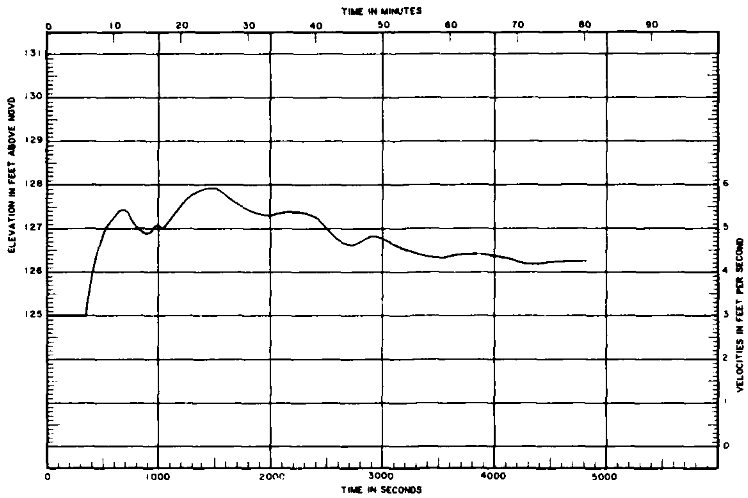
LEGEND

— MODEL DATA

VELOCITIES AND SURGES

ORIGINAL DESIGN

LOCK EMPTYING TIME	8.5 MIN
POWERHOUSE DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	131.0
UPPER POOL EL	252.0



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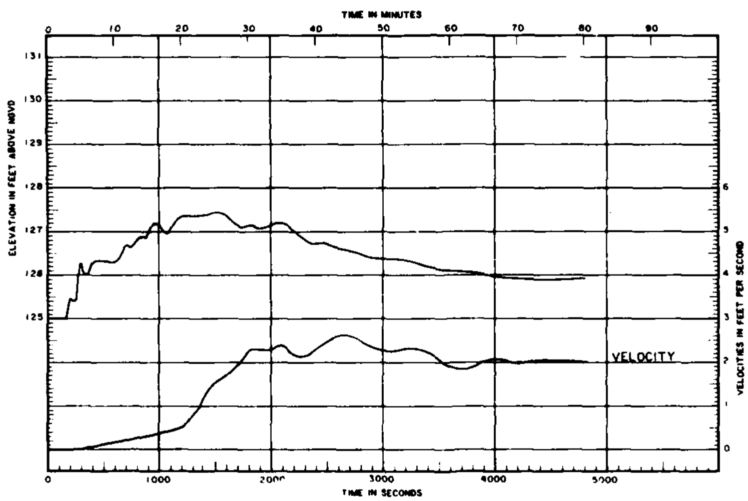


STATION 13

LEGEND

— MODEL DATA

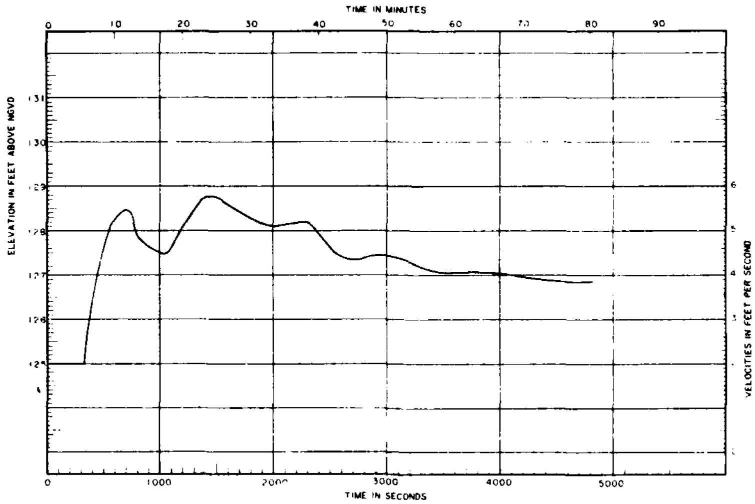
-- COMPUTED DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0-9,000 CFS
INITIAL TAILWATER EL	125.0



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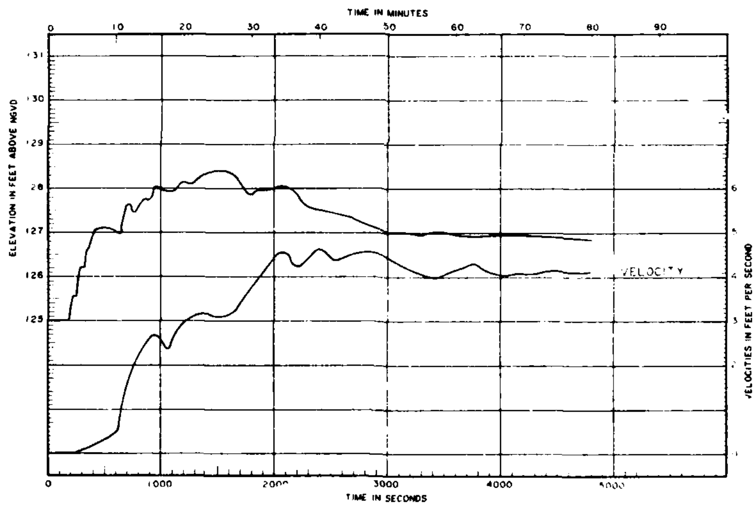


STATION 13

LEGEND

— MODEL DATA

-- COMPUTED DATA

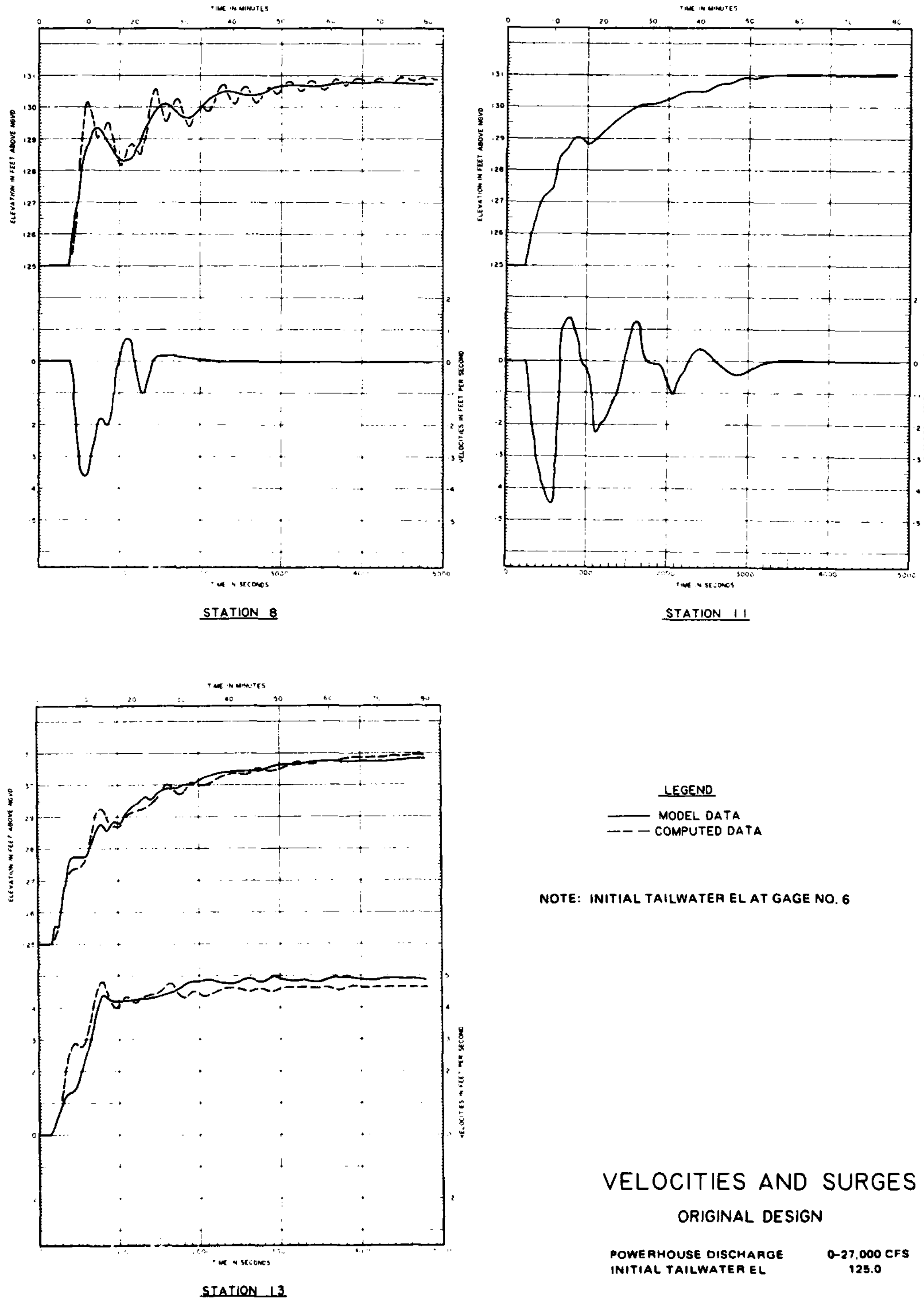
NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE 0-18,000 CFS
INITIAL TAILWATER EL 125.0

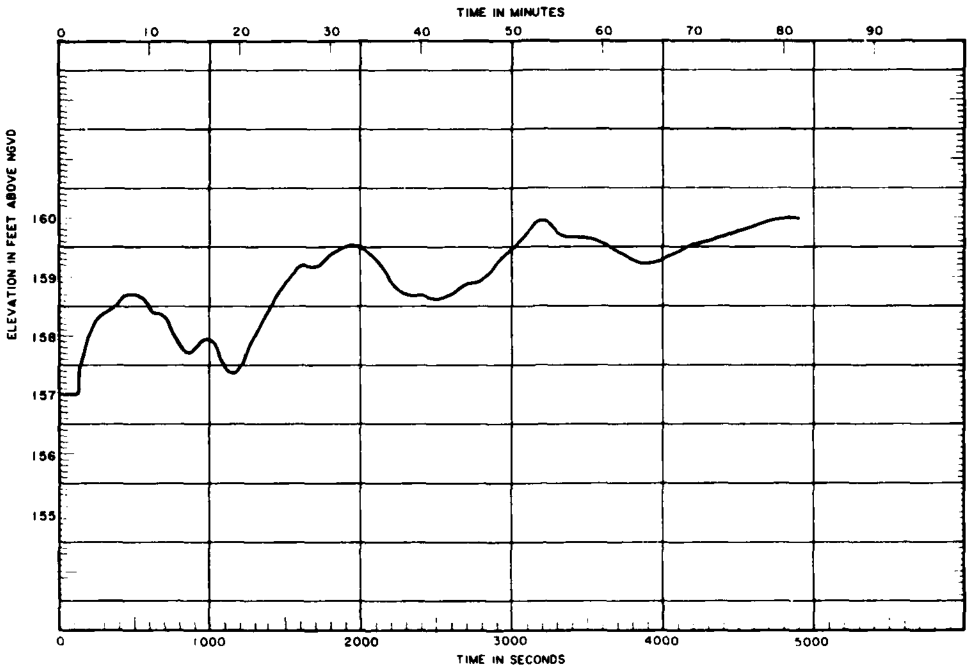
PLATE 12



VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	125.0



STATION 8

LEGEND

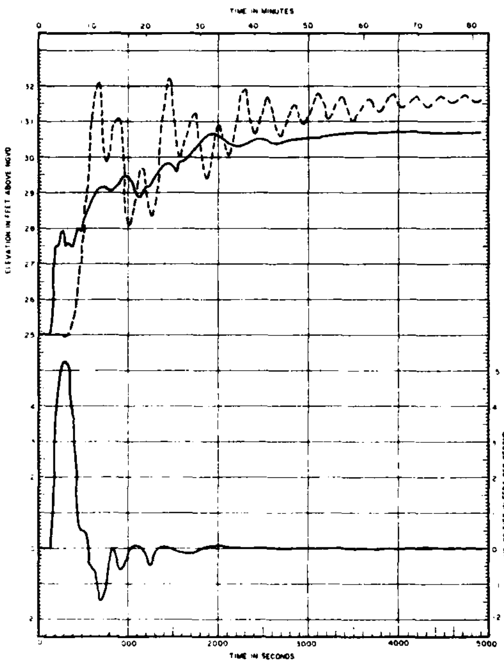
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

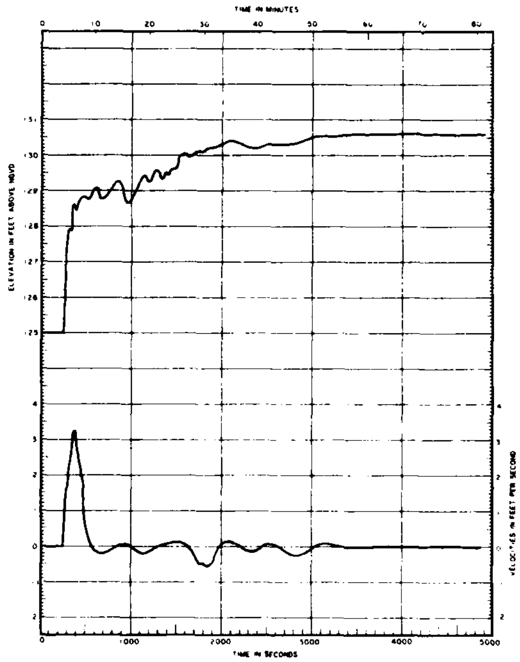
SURGES

ORIGINAL DESIGN

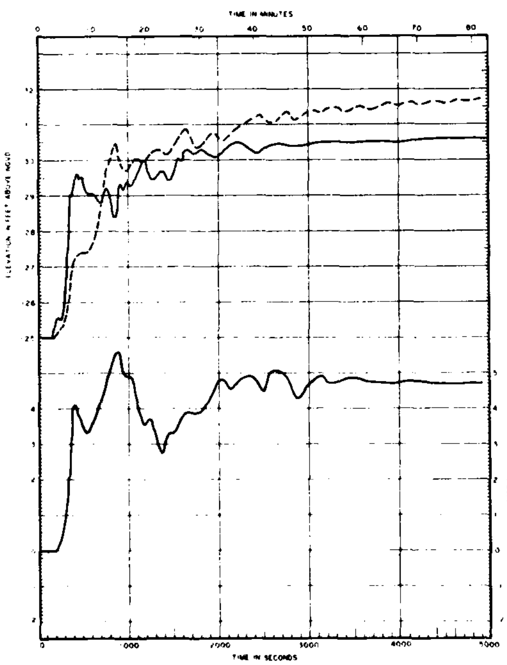
POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	157.4



STATION 8



STATION 11



STATION 13

LEGEND

—— MODEL DATA

– – – COMPUTED DATA

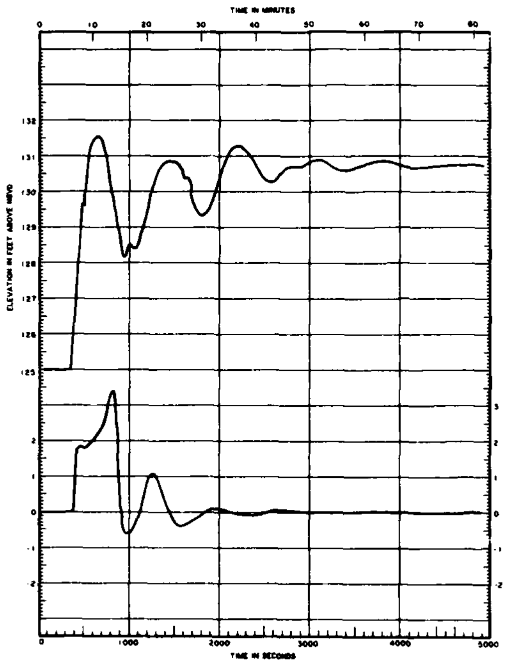
NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

VELOCITIES AND SURGES

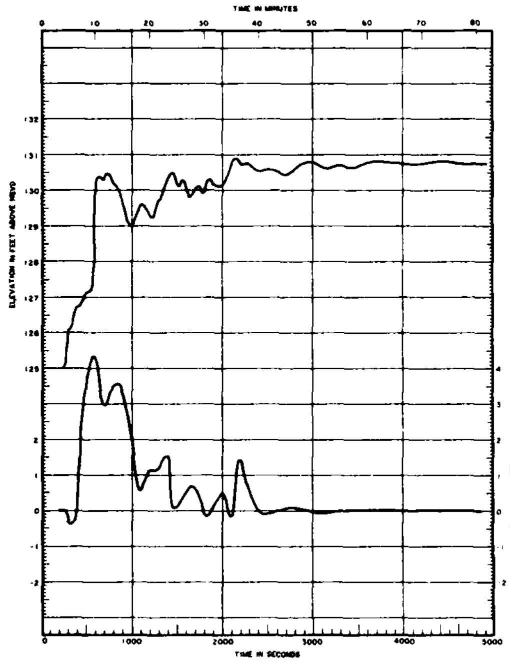
ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0

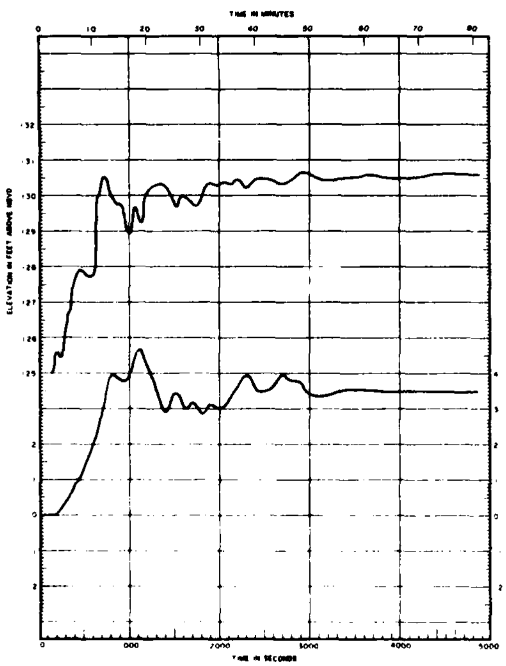
PLATE 15



STATION 8



STATION 11



STATION 13

LEGEND

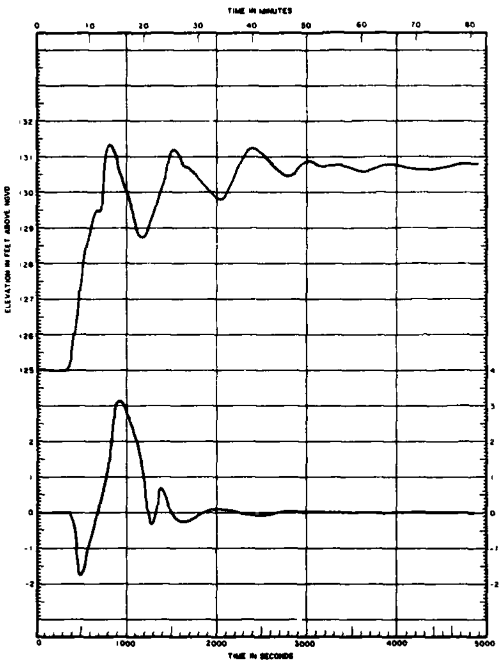
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

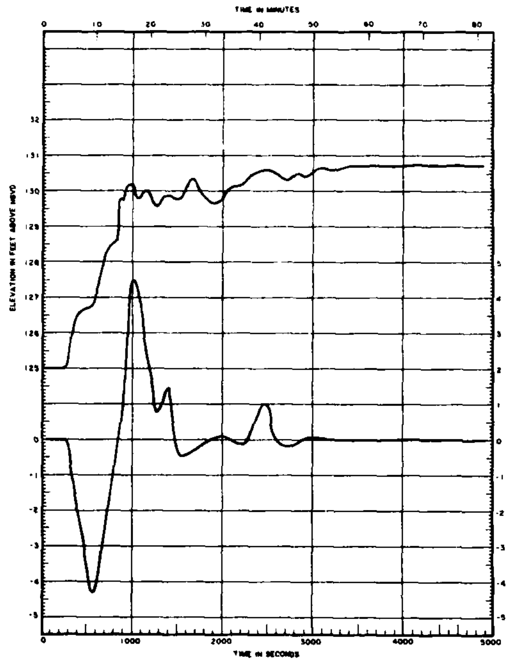
VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0–27,000 CFS
LOCK EMPTYING DELAYED	5 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



STATION 8



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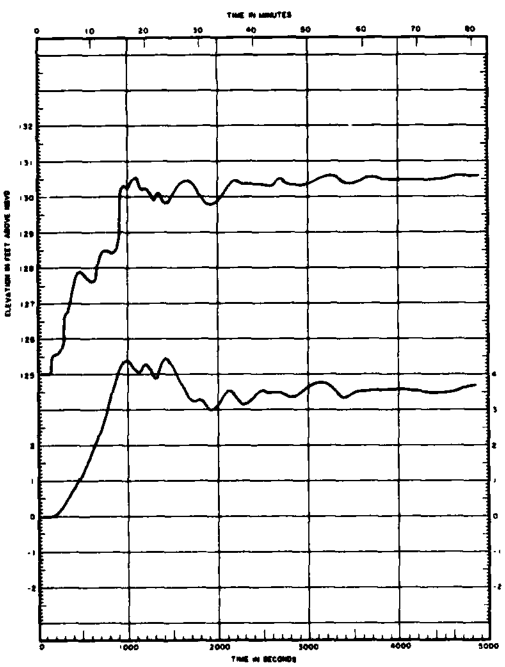


STATION 13

LEGEND

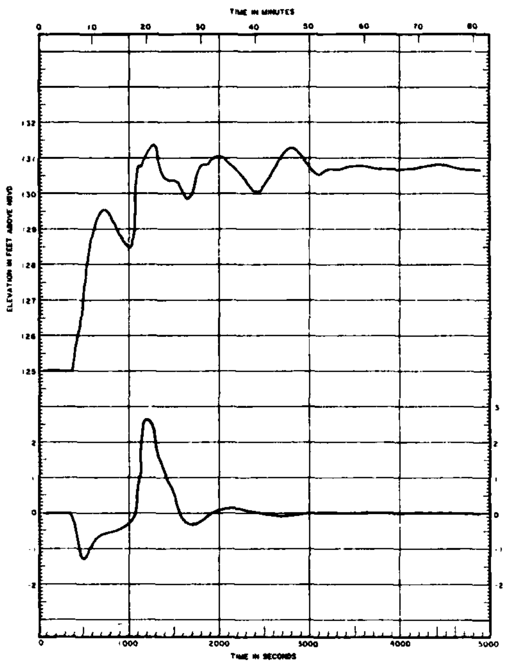
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0-27,000 CFS
LOCK EMPTYING DELAYED	10 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



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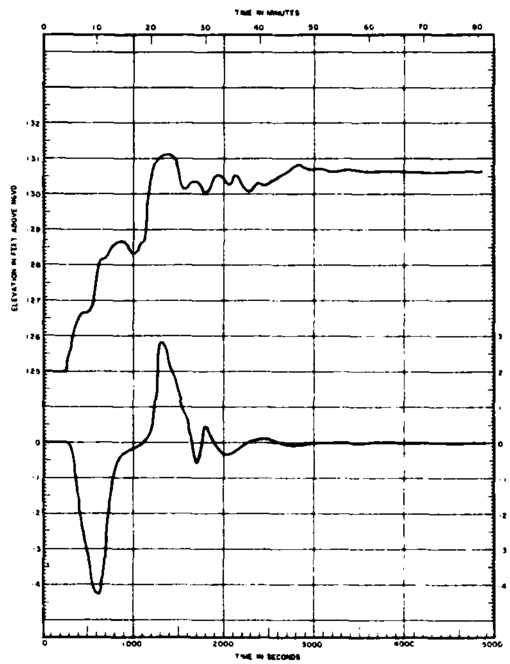

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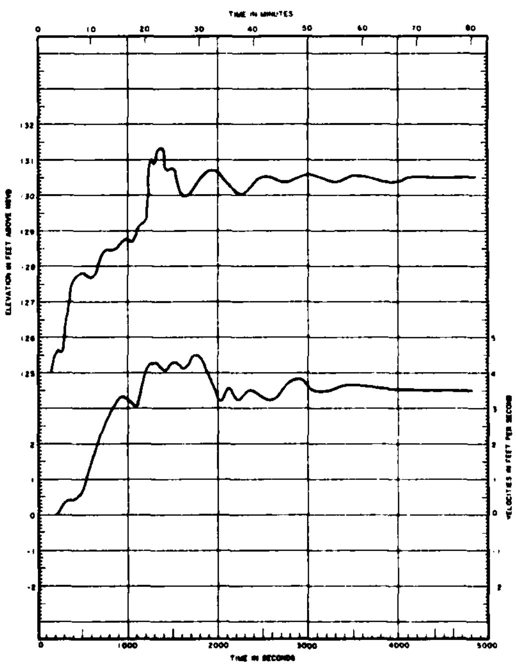


STATION 13

LEGEND

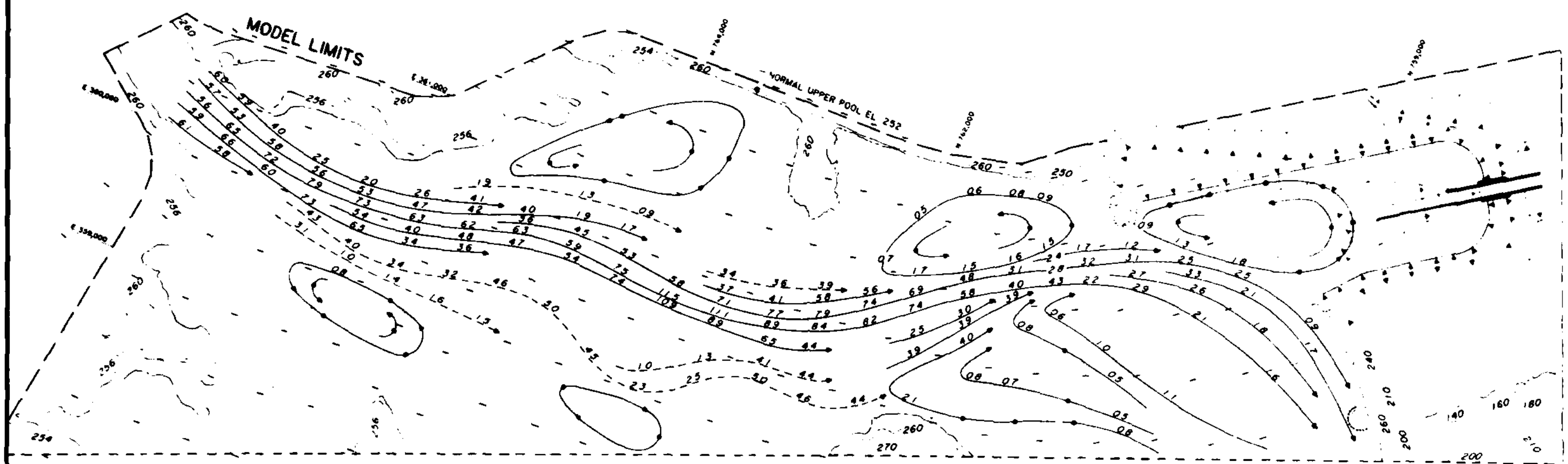
—— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

VELOCITIES AND SURGES

ORIGINAL DESIGN

POWERHOUSE DISCHARGE	0-27,000 CFS
LOCK EMPTYING DELAYED	15 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED TO 6.0 FT

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 27,000 CFS

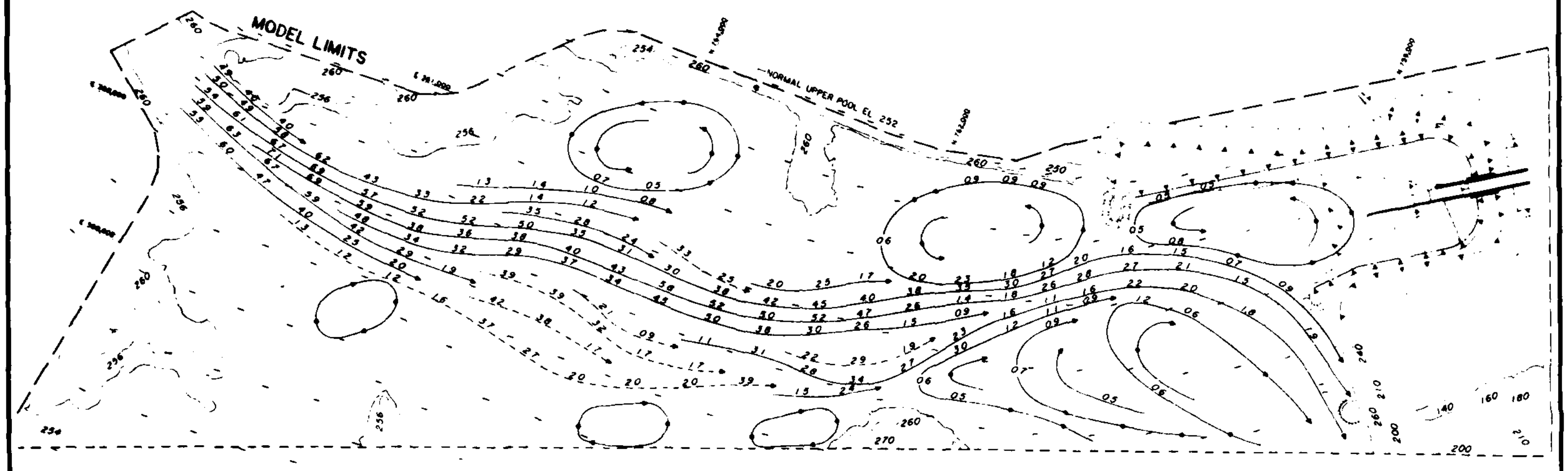
UPPER POOL EL 242.0

SCALES

PROTOTYPE 500 0 500 1000 FT

MODEL 5 0 5 10 FT

PLATE 20



LEGEND

- → VELOCITY IN FEET PER SECOND
- • → VELOCITY LESS THAN 0.5 FEET PER SECOND
- - - → FLOAT SUBMERGED TO 6.0 FT

NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

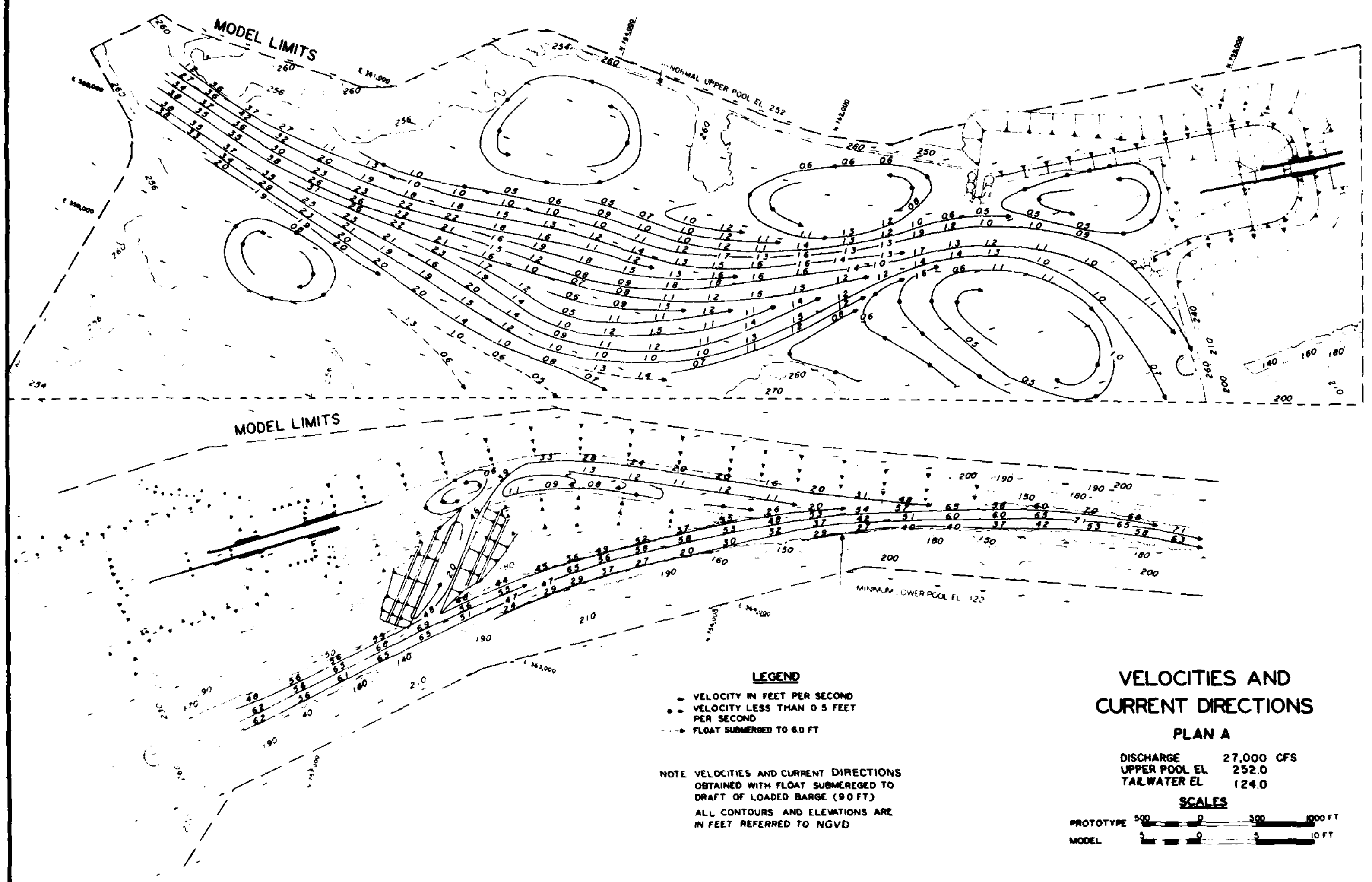
VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 27,000 CFS
UPPER POOL EL 245.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED TO 6.0 FT

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 27,000 CFS
UPPER POOL EL 252.0
TAILWATER EL 124.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 21

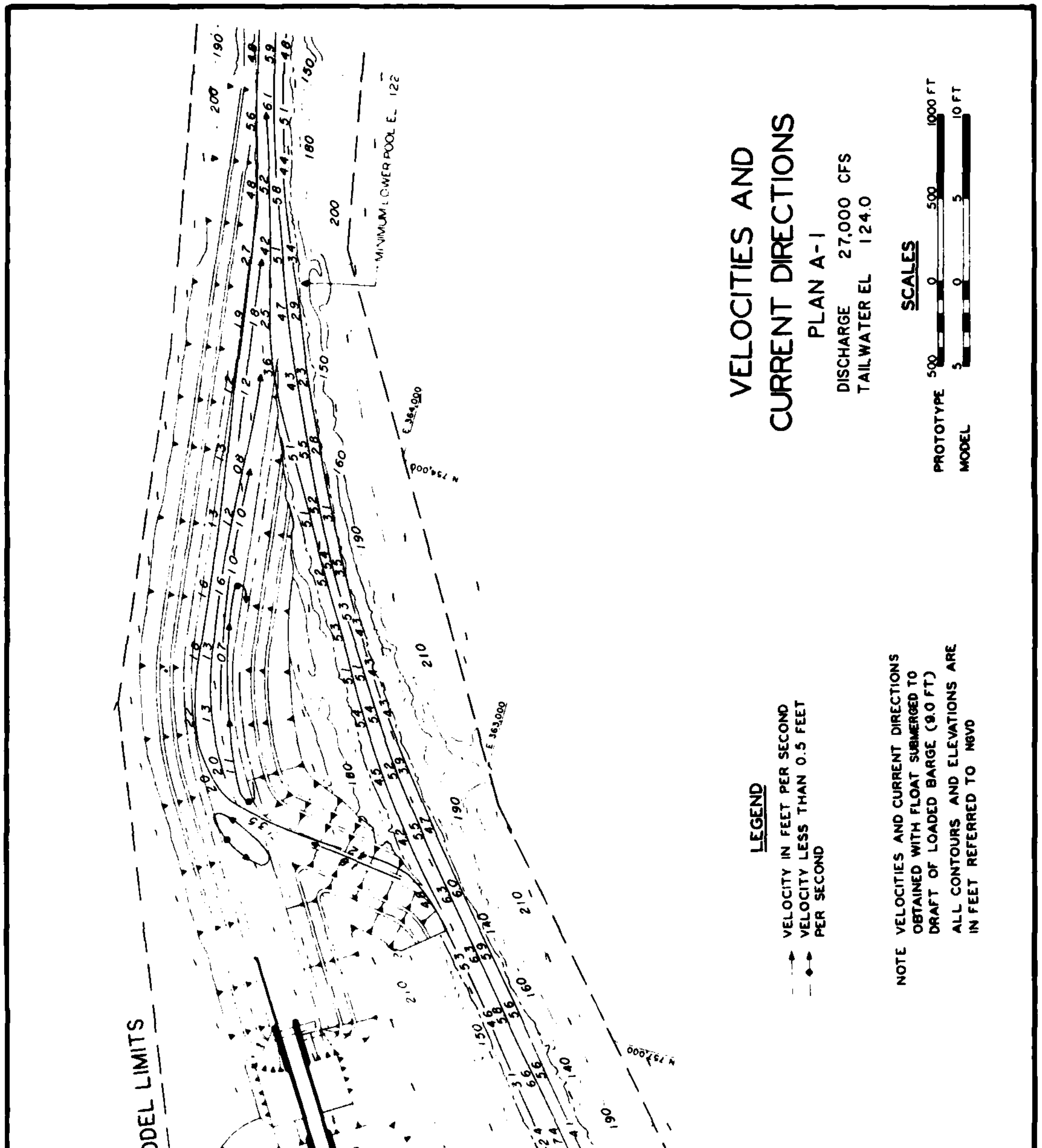
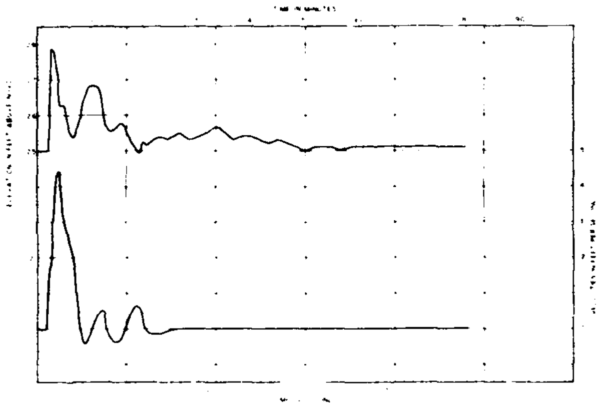
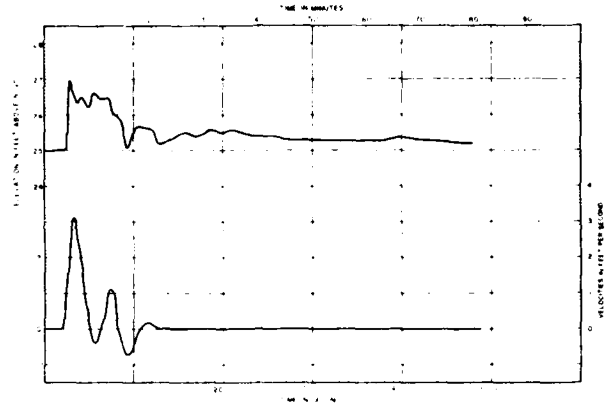

VELOCITIES AND
CURRENT DIRECTIONS
PLAN A-1
DISCHARGE 27,000 CFS
TAILWATER EL 124.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MINIMUM LOWER POOL EL 122
E 364,000
N 754,000
E 363,000
N 753,000

PLATE 22



STATION 8



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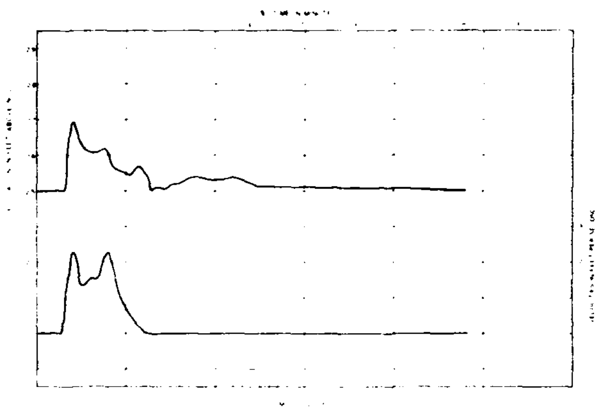


STATION 13

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

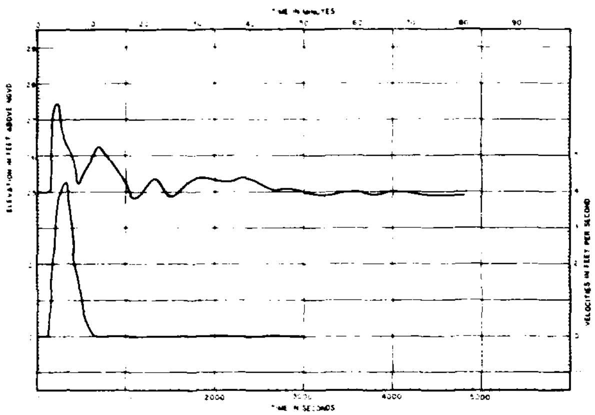
LEGEND

— MODEL DATA

VELOCITIES AND SURGES

PLAN A

POWERHOUSE DISCHARGE	0 CFS
LOCK EMPTYING TIME	8.5 MIN
INITIAL TAILWATER EL	126.0
UPPER POOL EL	252.0



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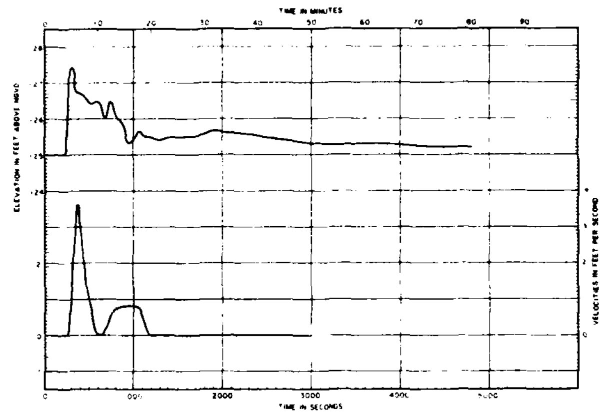

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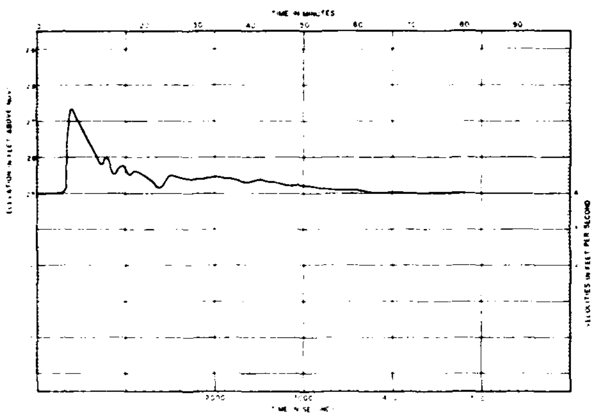


STATION 13

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

LEGEND

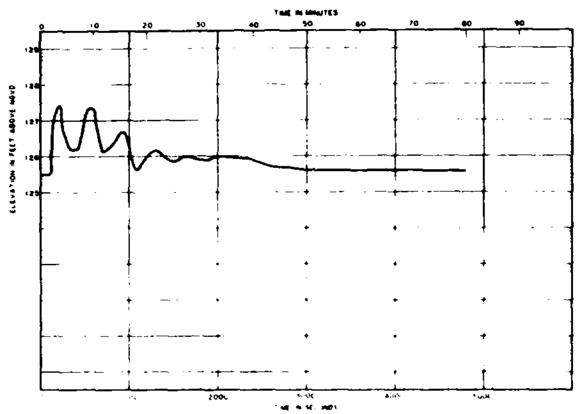
— MODEL DATA

VELOCITIES AND SURGES

PLAN A-1

POWERHOUSE DISCHARGE	0 CFS
LOCK EMPTYING TIME	8.5 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0

PLATE 24



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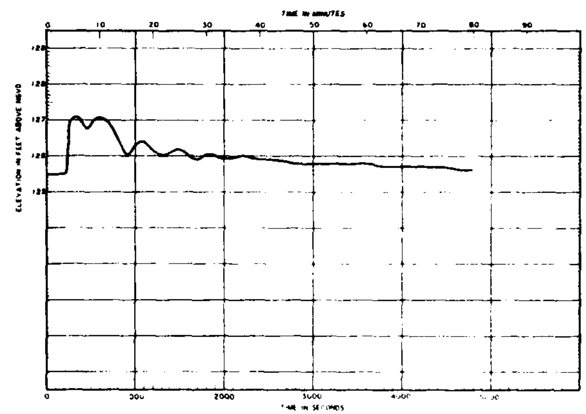

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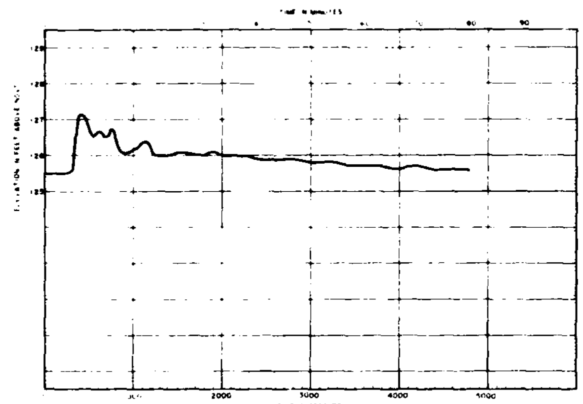


STATION 13

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

LEGEND

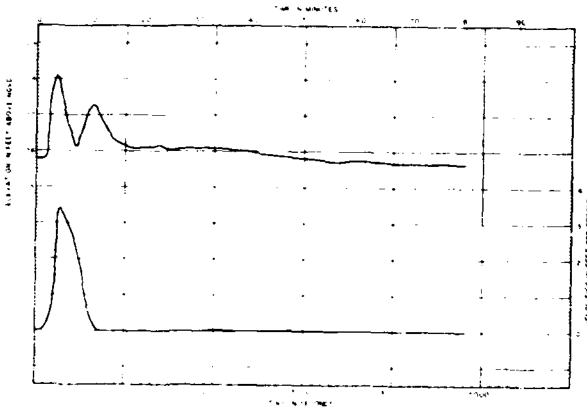
— MODEL DATA

SURGES

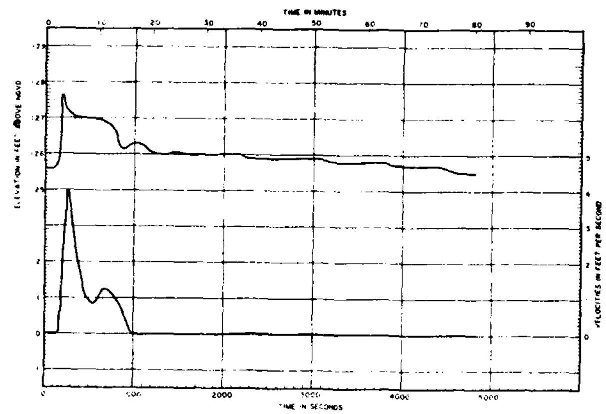
PLAN A

LOCK EMPTYING

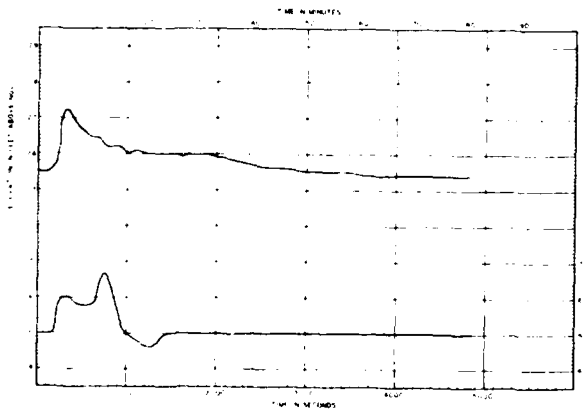
POWERHOUSE DISCHARGE	27,000 CFS
LOCK EMPTYING TIME	8.5 MIN
INITIAL TAILWATER EL	125.4
UPPER POOL EL	252.0



STATION 8



STATION 11



STATION 13

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

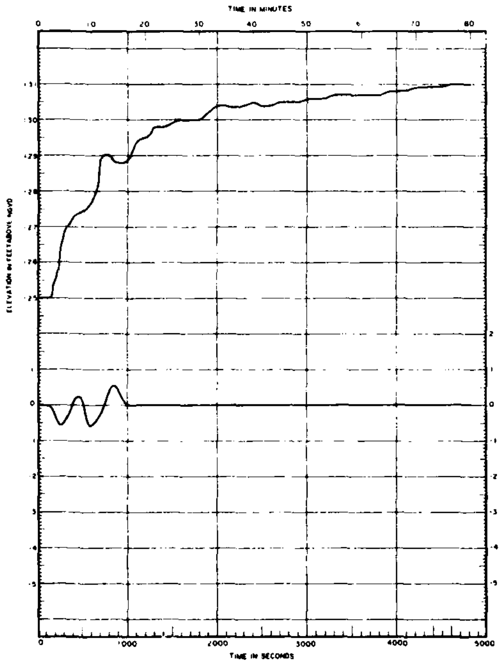
LEGEND

— MODEL DATA

VELOCITIES AND SURGES

PLAN A-1

LOCK EMPTYING TIME	8.5 MIN
POWERHOUSE DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	125.4
UPPER POOL EL	282.0



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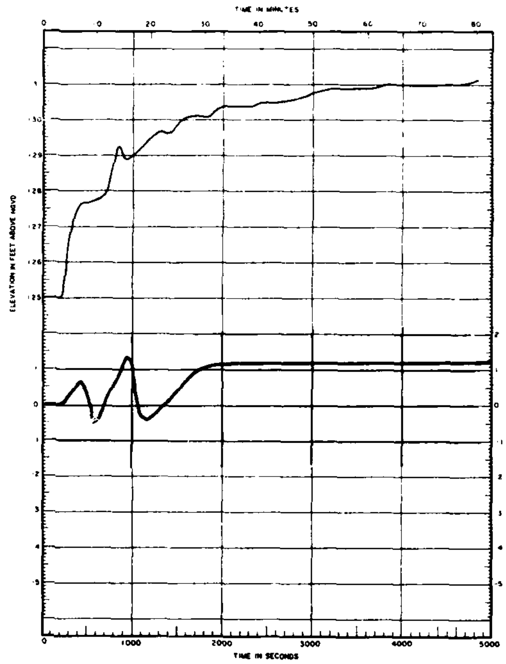

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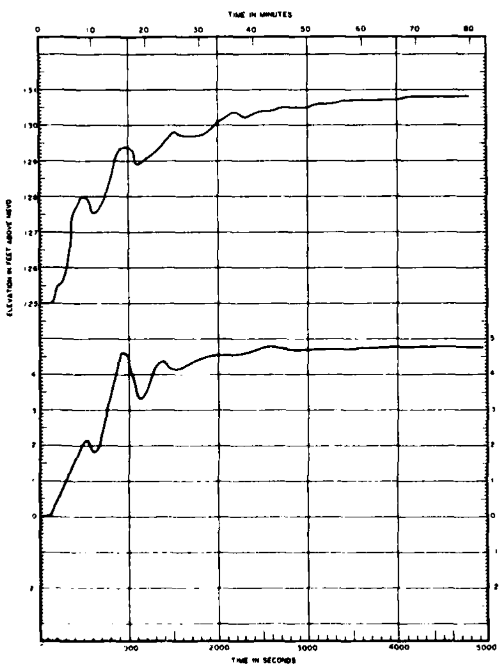


STATION 13

LEGEND

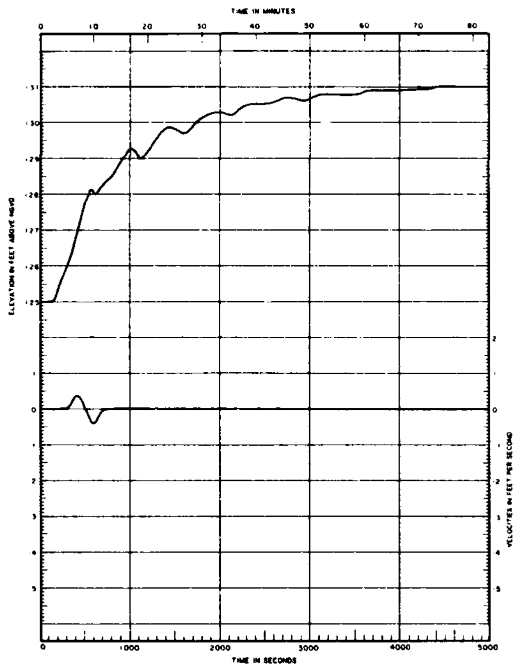
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

VELOCITIES AND SURGES

PLAN A

POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	125.0



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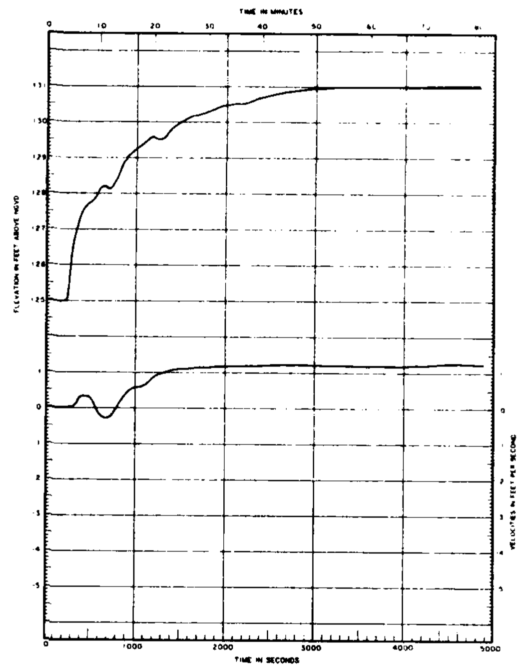
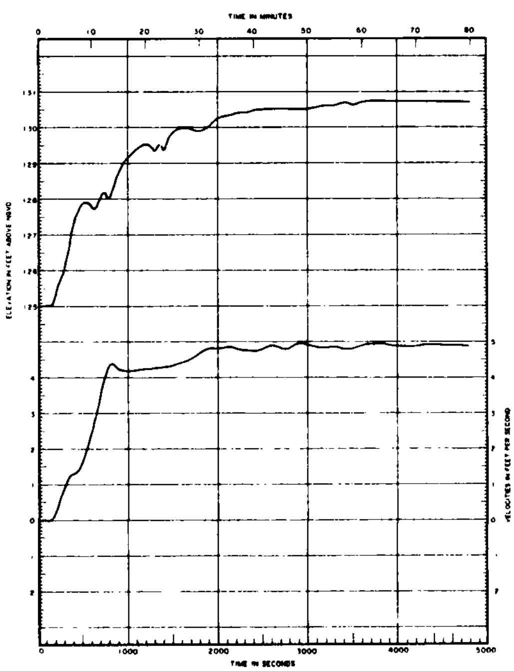


STATION 11



STATION 13

LEGEND

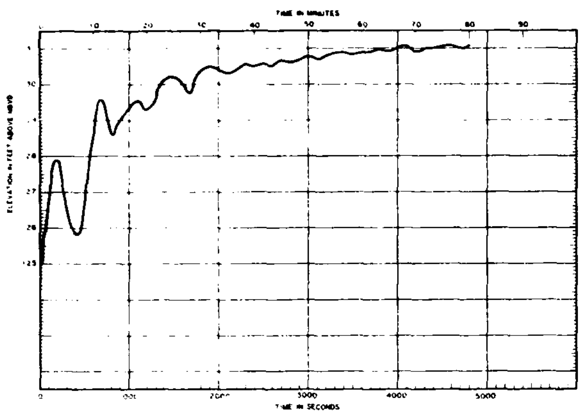
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

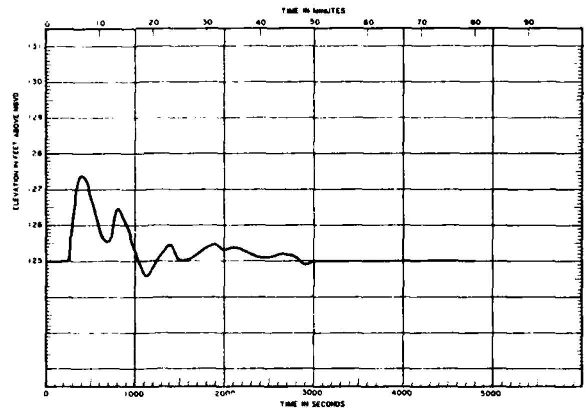
VELOCITIES AND SURGES

PLAN A-1

POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	125.0

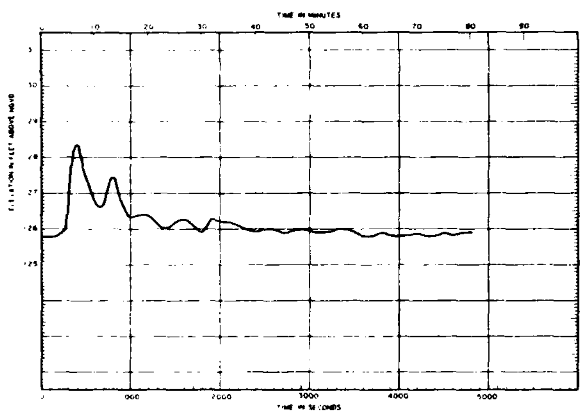


POWERHOUSE DISCHARGE 0–27,000 CFS
INITIAL TAILWATER EL 125.0

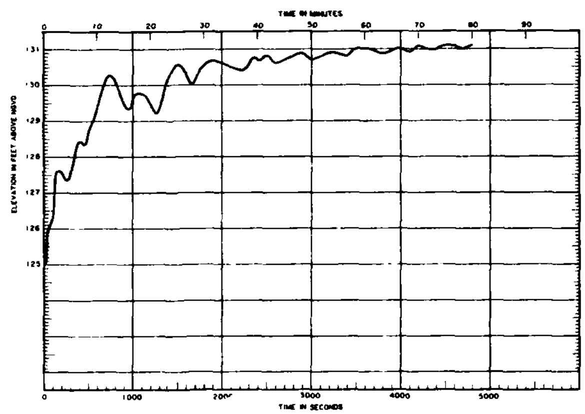


POWERHOUSE DISHCARGE 0 CFS
LOCK EMPTYING TIME 8.5 MIN
INITIAL TAILWATER EL 125.0

NOTE: UPPER POOL EL 252.0.
INITIAL TAILWATER EL AT GAGE NO. 6.



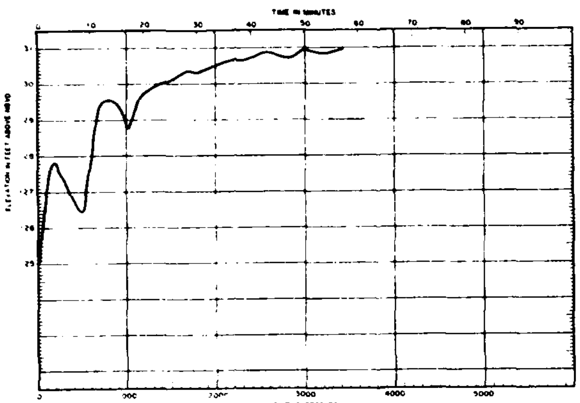
POWERHOUSE DISCHARGE 27,000 CFS
LOCK EMPTYING TIME 8.5 MIN
INITIAL TAILWATER EL 125.4



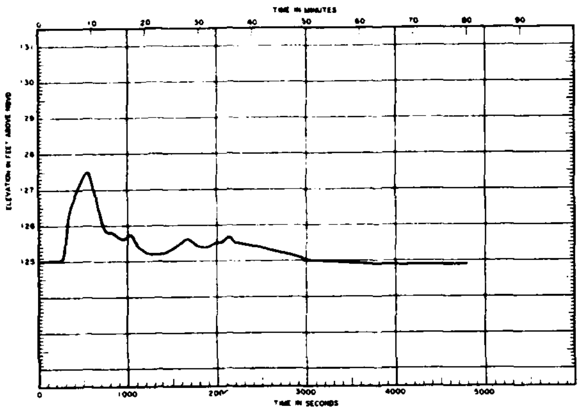
POWERHOUSE DISHCARGE 0–27,000 CFS
SIMULTANEOUS LOCK EMPTYING
INITIAL TAILWATER EL 125.0

LEGEND
— MODEL DATA

SURGES AT STATION 1
PLAN A

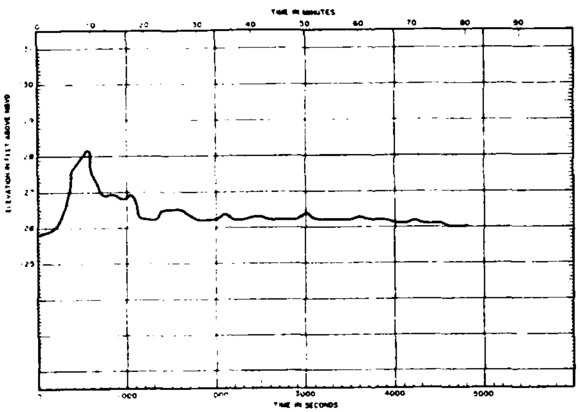


POWERHOUSE DISCHARGE 0-27,000 CFS
INITIAL TAILWATER EL 125.0

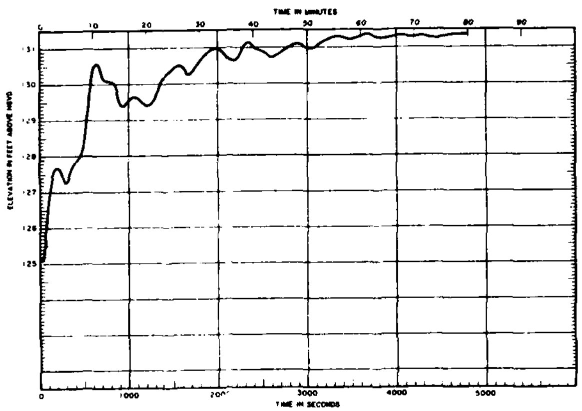


POWERHOUSE DISCHARGE 0 CFS
LOCK EMPTYING TIME 8.5 MIN
INITIAL TAILWATER EL 125.0

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
UPPER POOL EL 252.0.



POWERHOUSE DISCHARGE 27,000 CFS
LOCK EMPTYING TIME 8.5 MIN
INITIAL TAILWATER EL 125.4

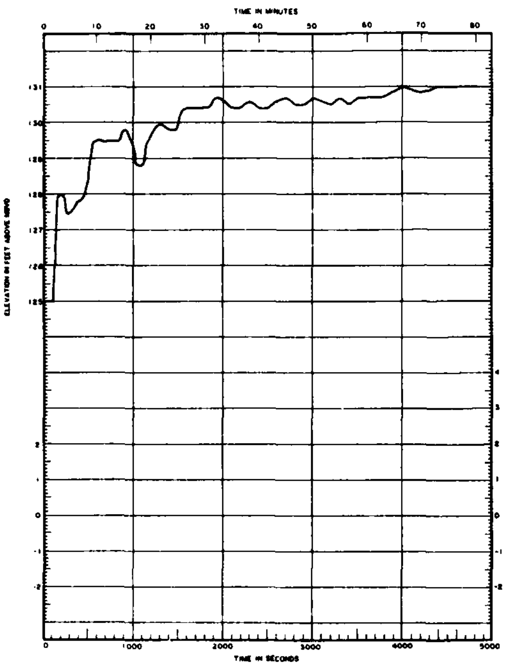


POWERHOUSE DISCHARGE 0-27,000 CFS
SIMULTANEOUS LOCK EMPTYING
INITIAL TAILWATER EL 125.0

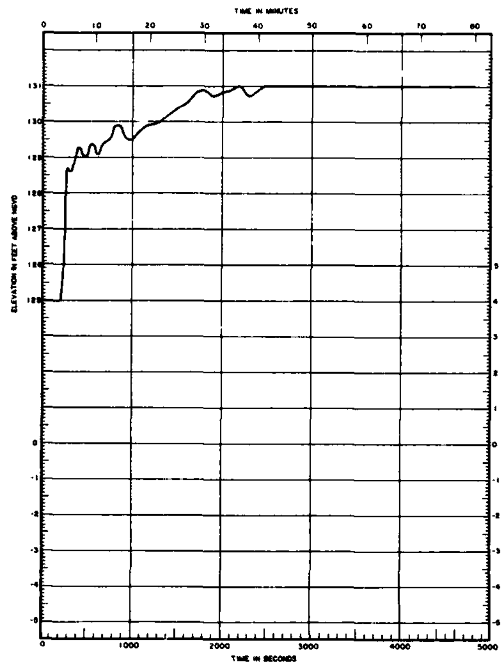
LEGEND
— MODEL DATA

SURGES AT STATION 1

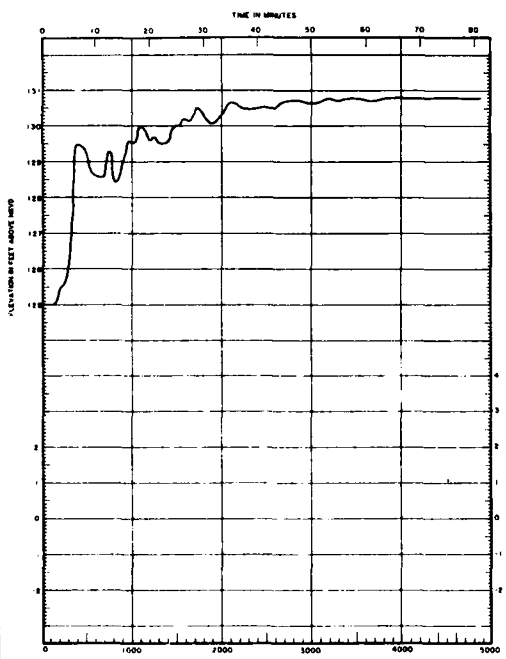
PLAN A-1



STATION 8



STATION 11



STATION 13

LEGEND

— MODEL DATA

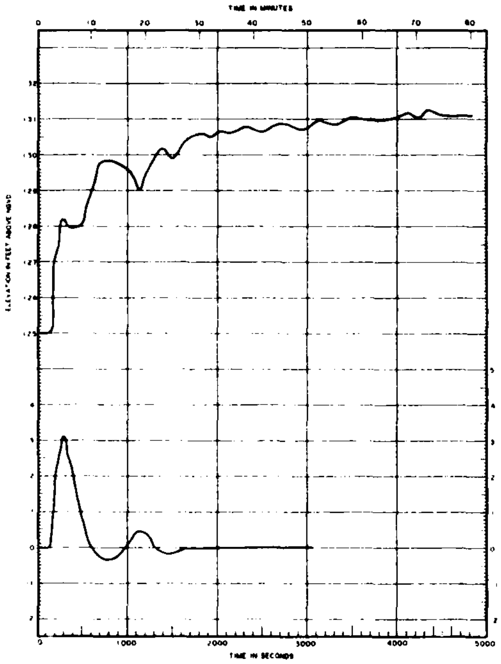
NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

VELOCITIES AND SURGES

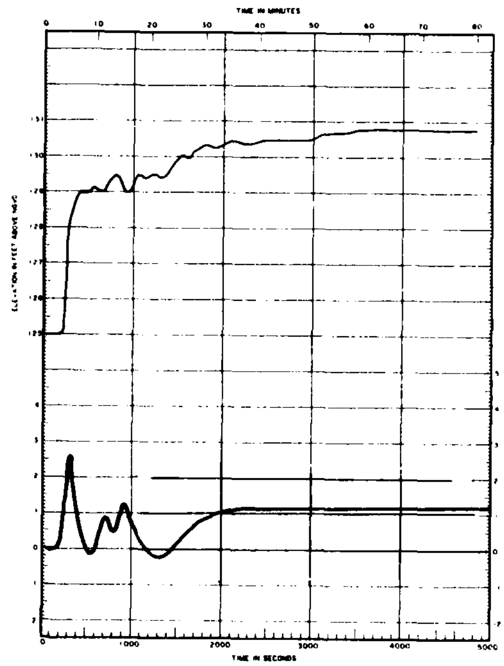
PLAN A

POWERHOUSE DISCHARGE	0-27,000 CFS
SIMULTANEOUS LOCK EMPTYING	
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0

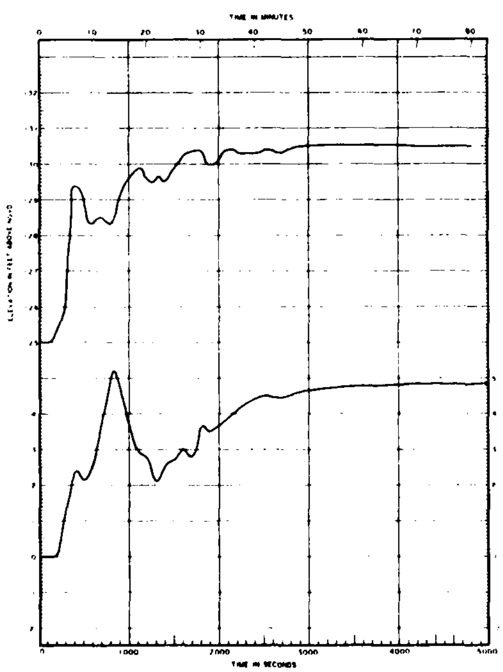
PLATE 31



STATION 8



STATION 11



STATION 13

LEGEND

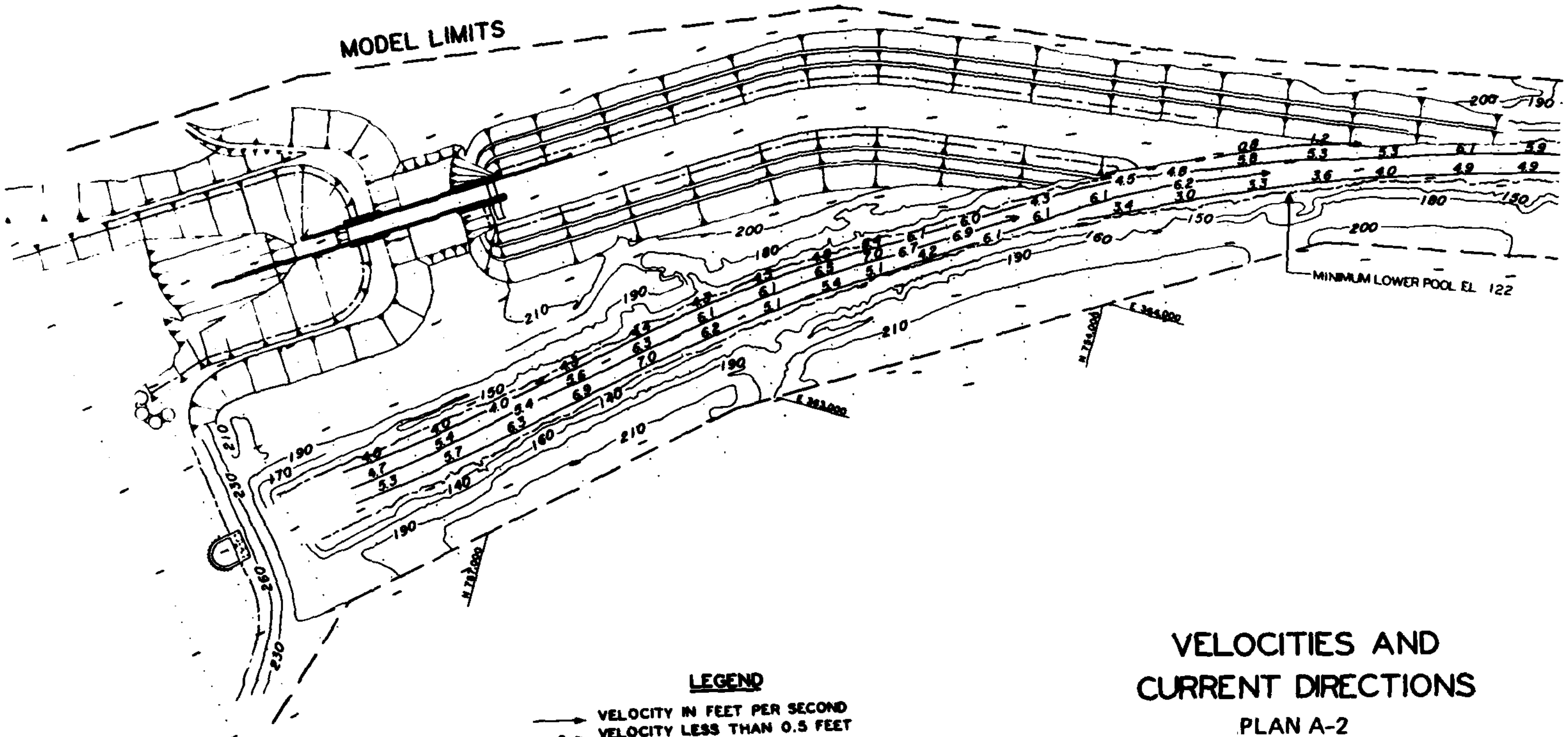
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

VELOCITIES AND SURGES

PLAN A-1

POWERHOUSE DISCHARGE	0-27,000 CFS
SIMULTANEOUS LOCK EMPTYING	
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



VELOCITIES AND CURRENT DIRECTIONS

PLAN A-2

DISCHARGE 27,000 CFS
TAILWATER EL 124.0

LEGEND

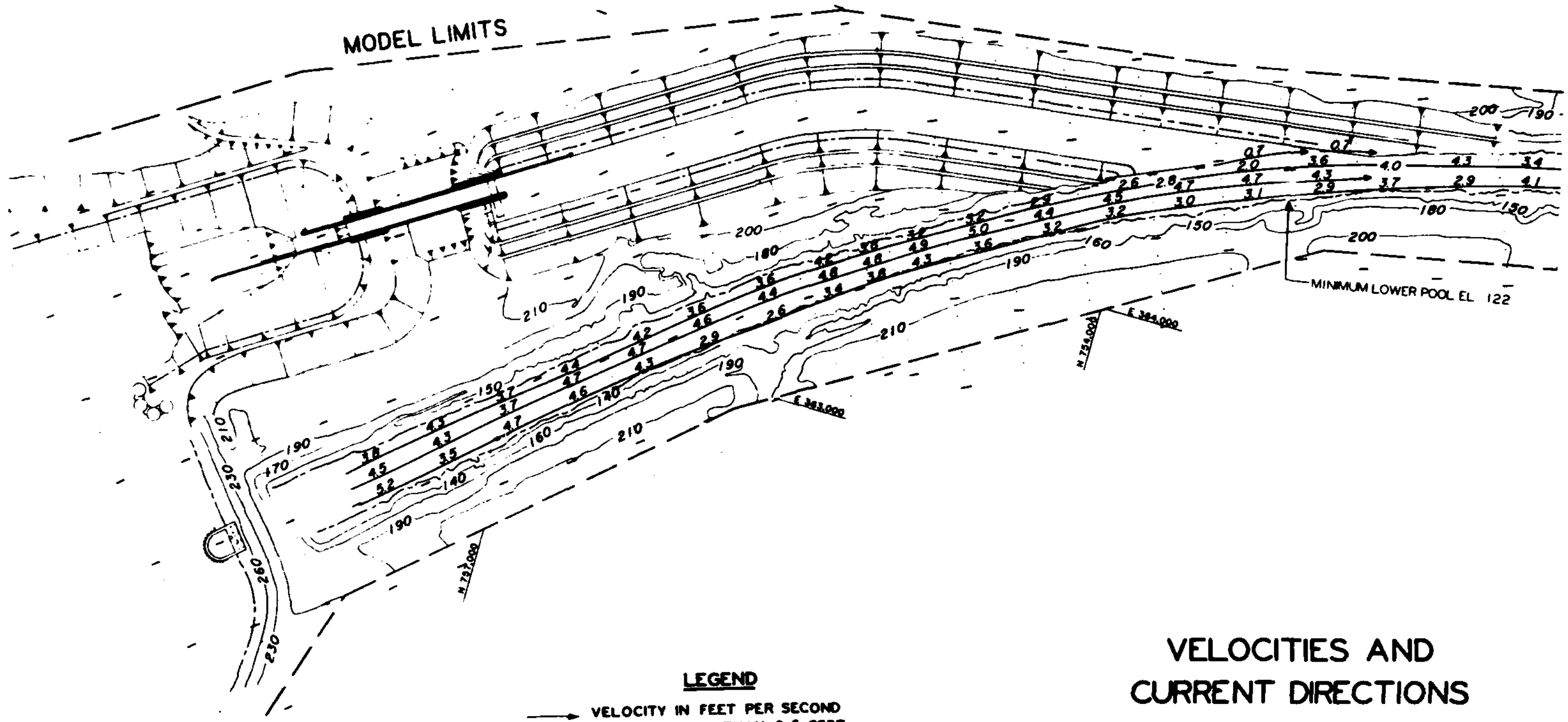
- → VELOCITY IN FEET PER SECOND
- →• VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT



VELOCITIES AND CURRENT DIRECTIONS

PLAN A-2

DISCHARGE 27,000 CFS
TAILWATER EL 131.0

LEGEND

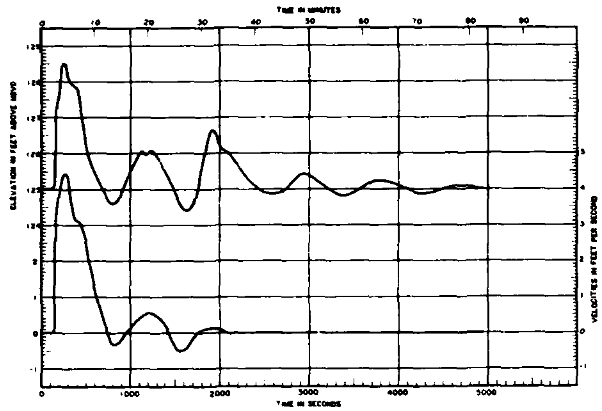
→ VELOCITY IN FEET PER SECOND
•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

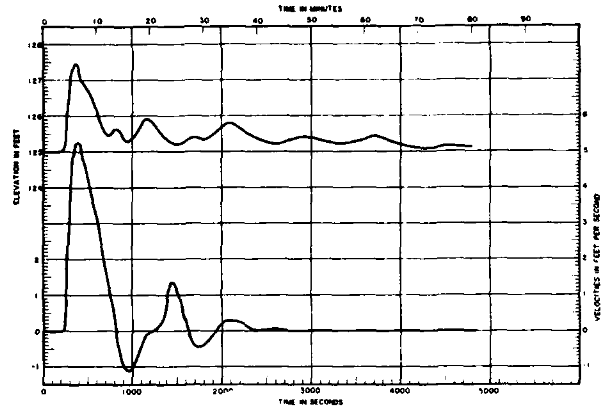
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

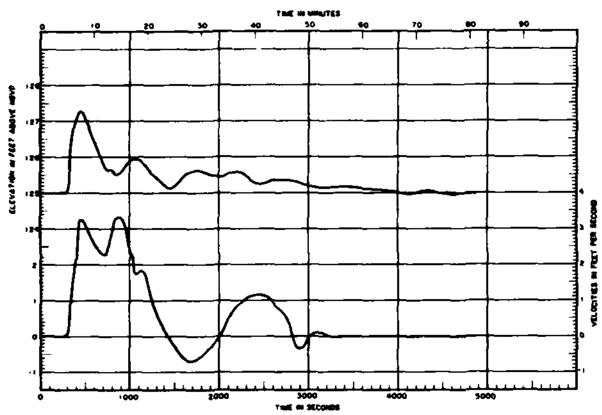
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT



STATION 8



STATION 11



STATION 13

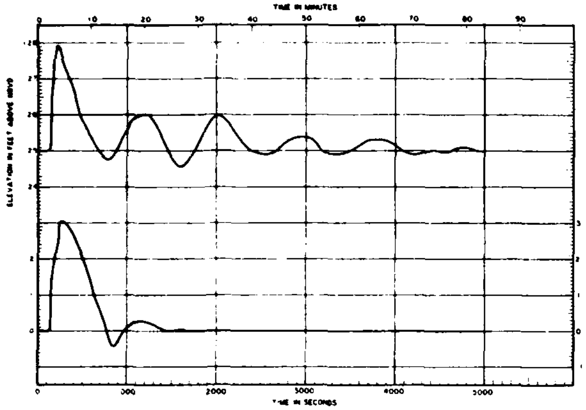
LEGEND

— MODEL DATA

VELOCITIES AND SURGES

PLAN A-2

POWERHOUSE DISCHARGE	0 CFS
LOCK EMPTYING TIME	8.5 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	282.0



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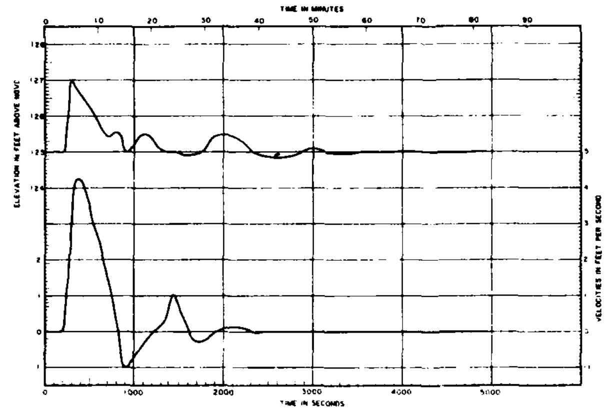

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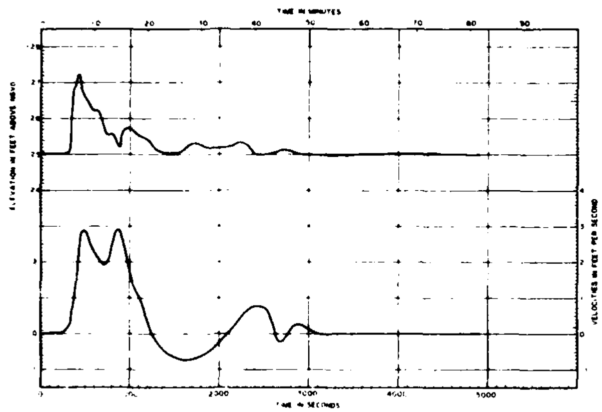


STATION 13

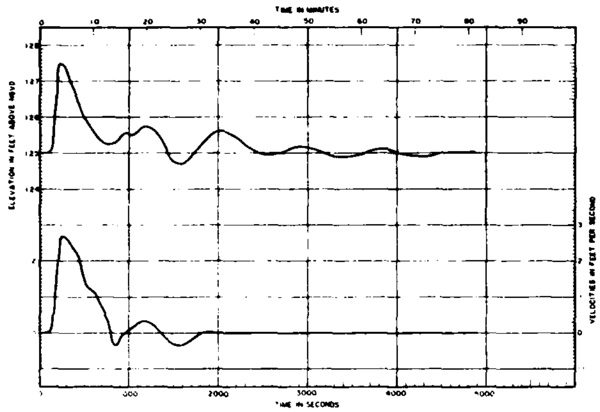
LEGEND

— MODEL DATA

VELOCITIES AND SURGES

PLAN A-2

POWERHOUSE DISCHARGE	0 CFS
LOCK EMPTYING TIME	12 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



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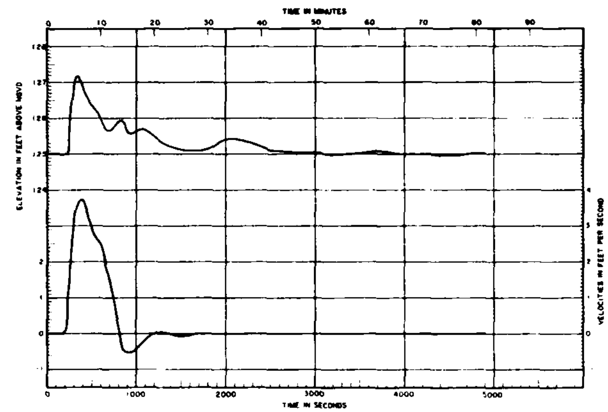
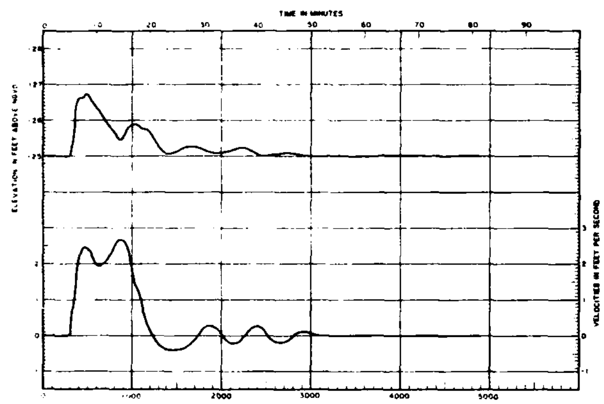


STATION 11



STATION 13

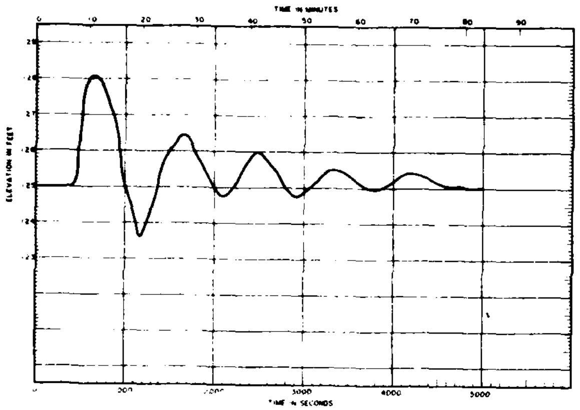
LEGEND

— MODEL DATA

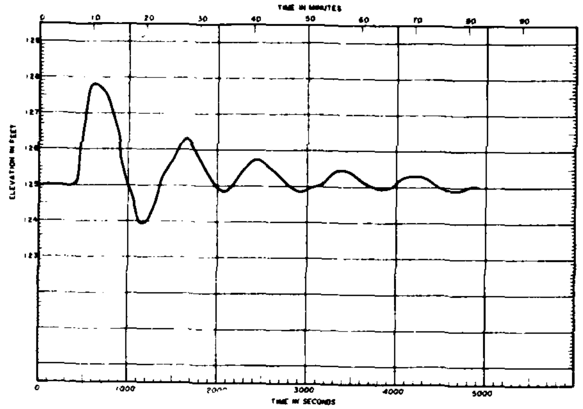
VELOCITIES AND SURGES

PLAN A-2

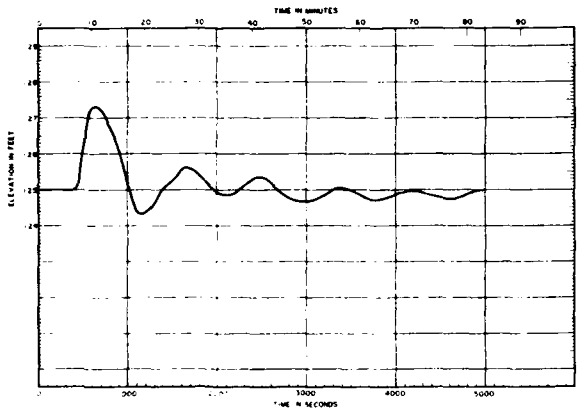
POWERHOUSE DISCHARGE	0 CFS
LOCK EMPTYING TIME	15 MIN
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



8.5 MINUTE LOCK EMPTYING



12 MINUTE LOCK EMPTYING



15 MINUTE LOCK EMPTYING

LEGEND

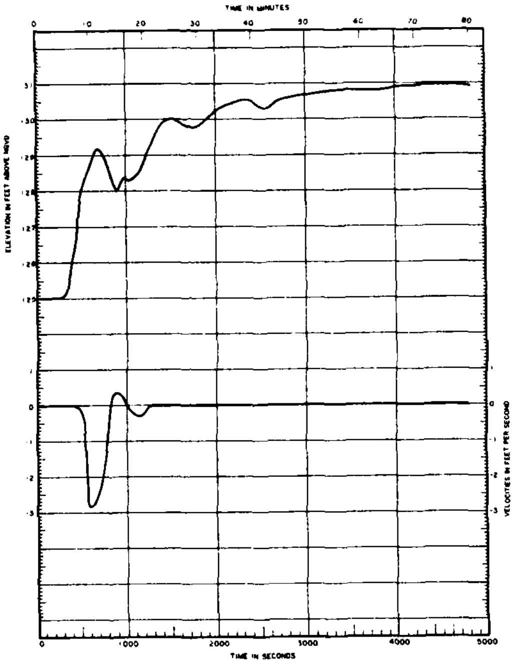
— MODEL DATA

SURGES AT STATION 1

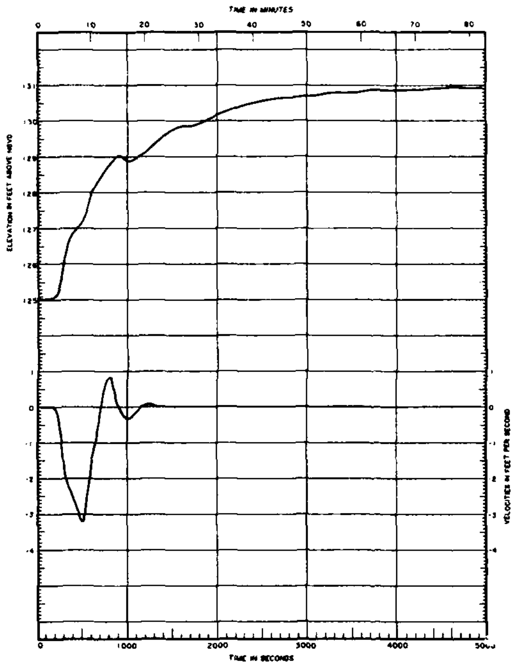
PLAN A-2

LOCK EMPTYING

POWERHOUSE DISCHARGE	0 CFS
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



STATION 8



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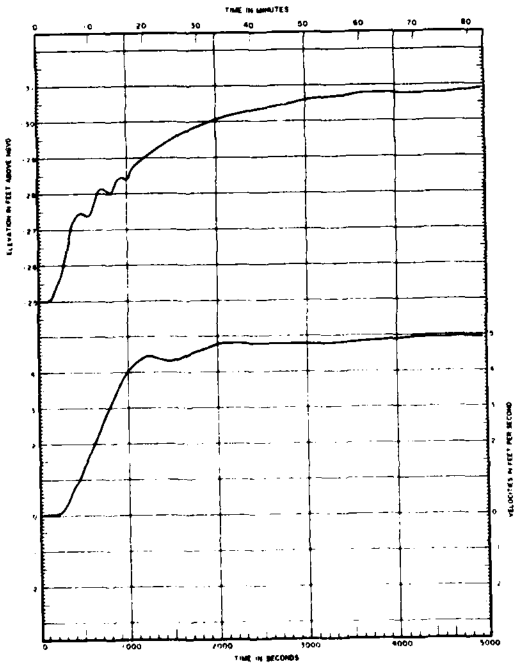


STATION 13

LEGEND

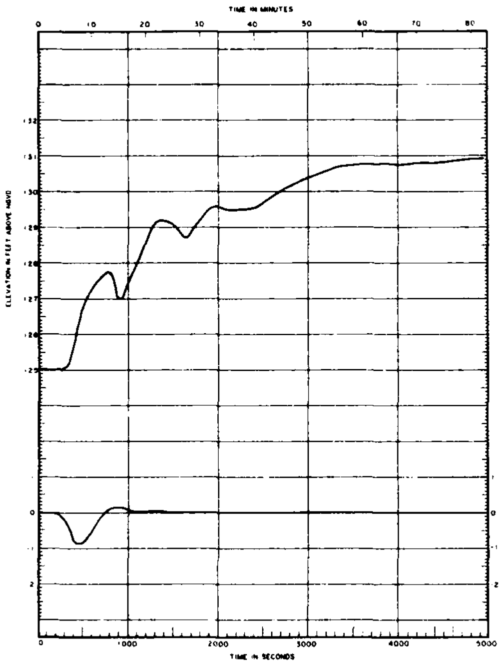
——— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

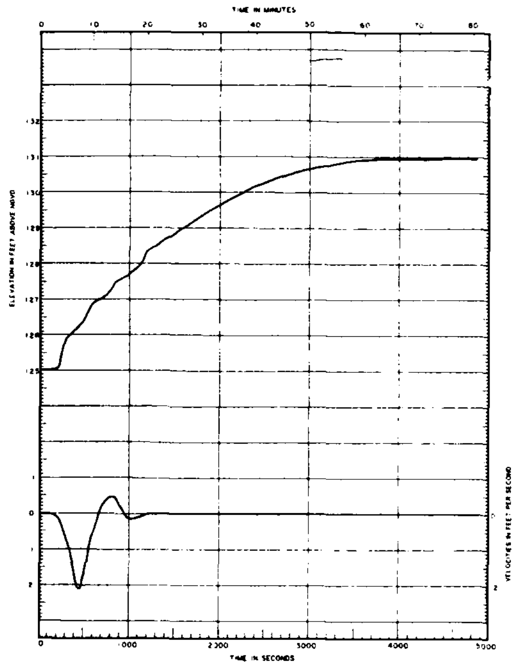
VELOCITIES AND SURGES

PLAN A-2

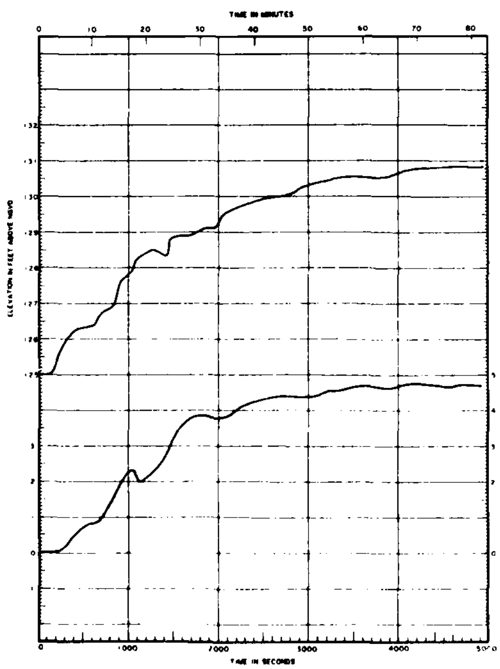
POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	125.0



STATION 8



STATION 11



STATION 13

LEGEND

——— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6

VELOCITIES AND SURGES

PLAN A-2

POWERHOUSE DISCHARGE	0-27,000 CFS
INITIAL TAILWATER EL	125.0
UNITS STARTED AT 10 MIN INTERVALS	

AD-A150 879 NAVIGATION CONDITIONS IN VICINITY OF WALTER BOULDIN LOCK AND DAM COOSA RI..(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS HYDRA.. 2/3

UNCLASSIFIED C M MYRICK ET AL. DEC 84 WES/TR/HL-84-11 F/G 13/2 NL

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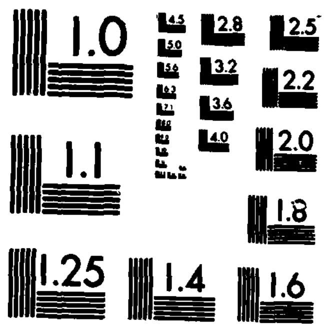
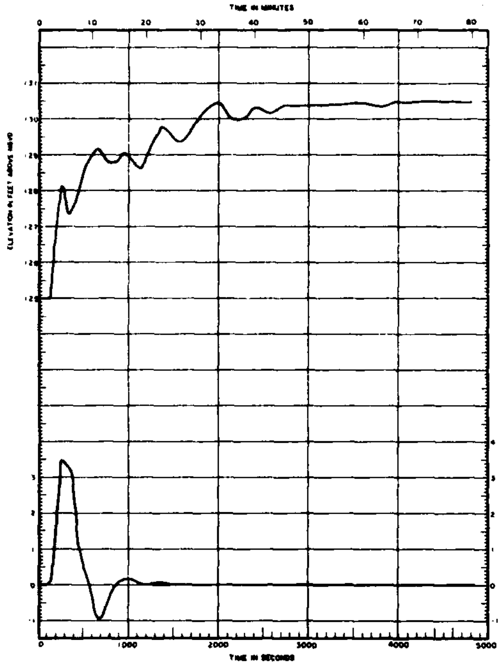


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



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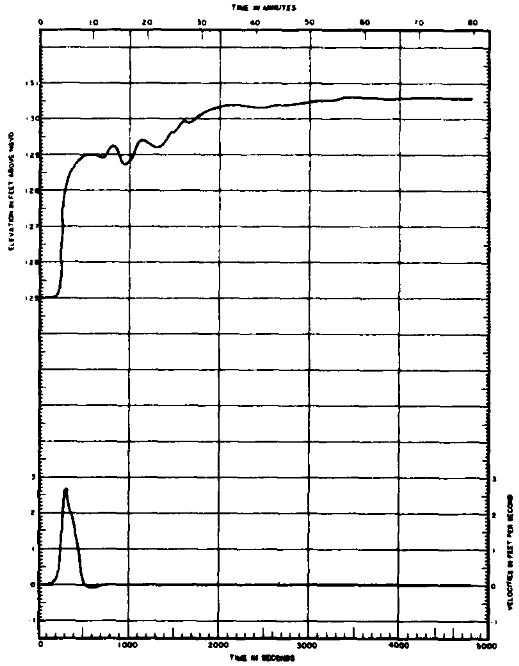

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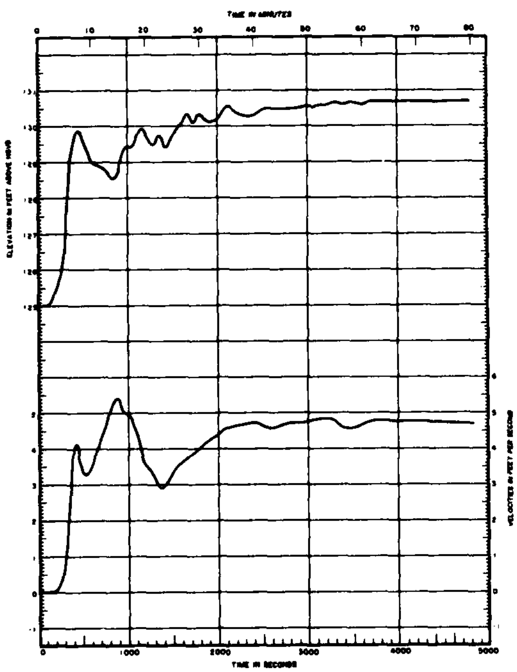


STATION 13

LEGEND

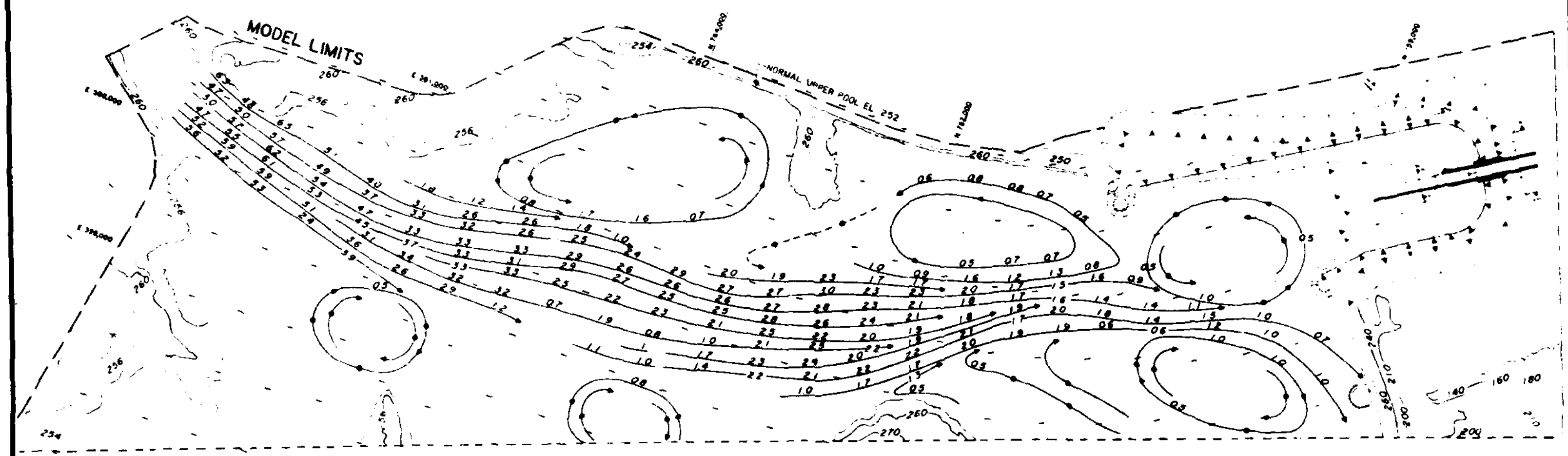
—— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 6.
LOCK EMPTYING TIME 8.5 MIN.

VELOCITIES AND SURGES

PLAN A-2

POWERHOUSE DISCHARGE	0-27,000 CFS
SIMULTANEOUS LOCK EMPTYING	
INITIAL TAILWATER EL	125.0
UPPER POOL EL	252.0



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED TO 6.0 FT

NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

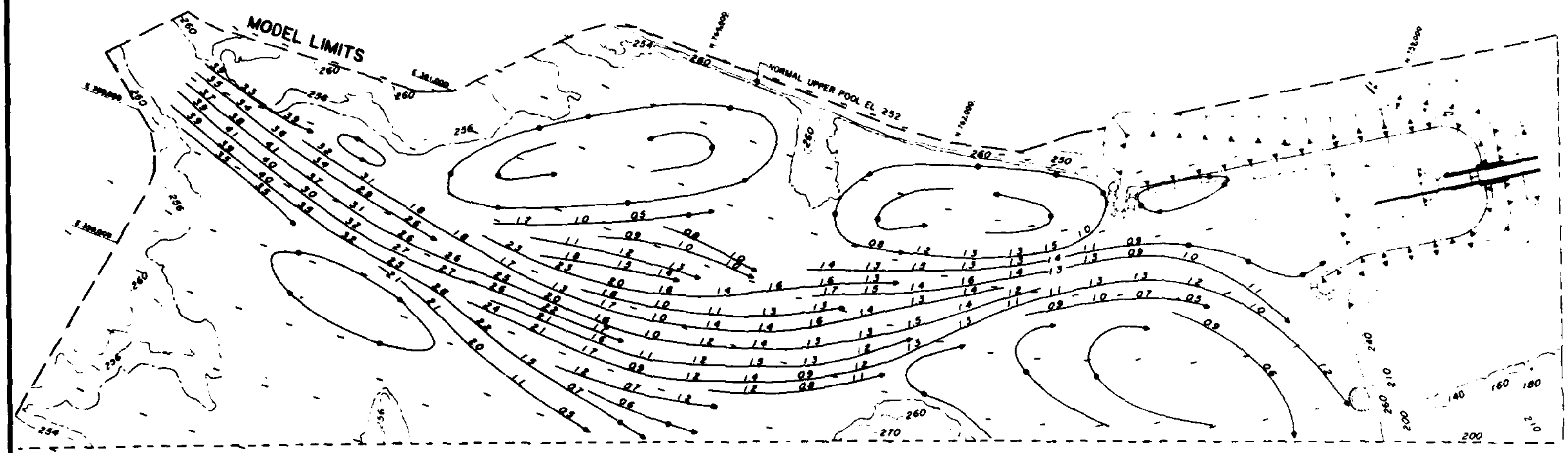
PLAN B

DISCHARGE 27,000 CFS
UPPER POOL EL 248.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 42



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

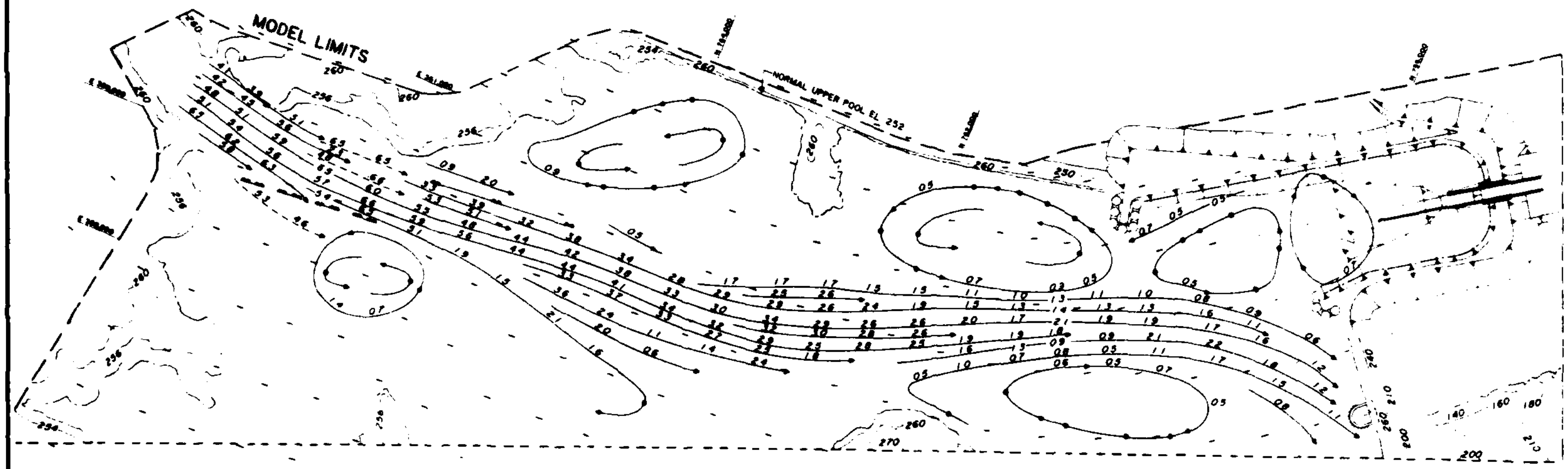
VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE 27,000 CFS
UPPER POOL EL 252.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED TO 6.0 FT
- DIKES

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

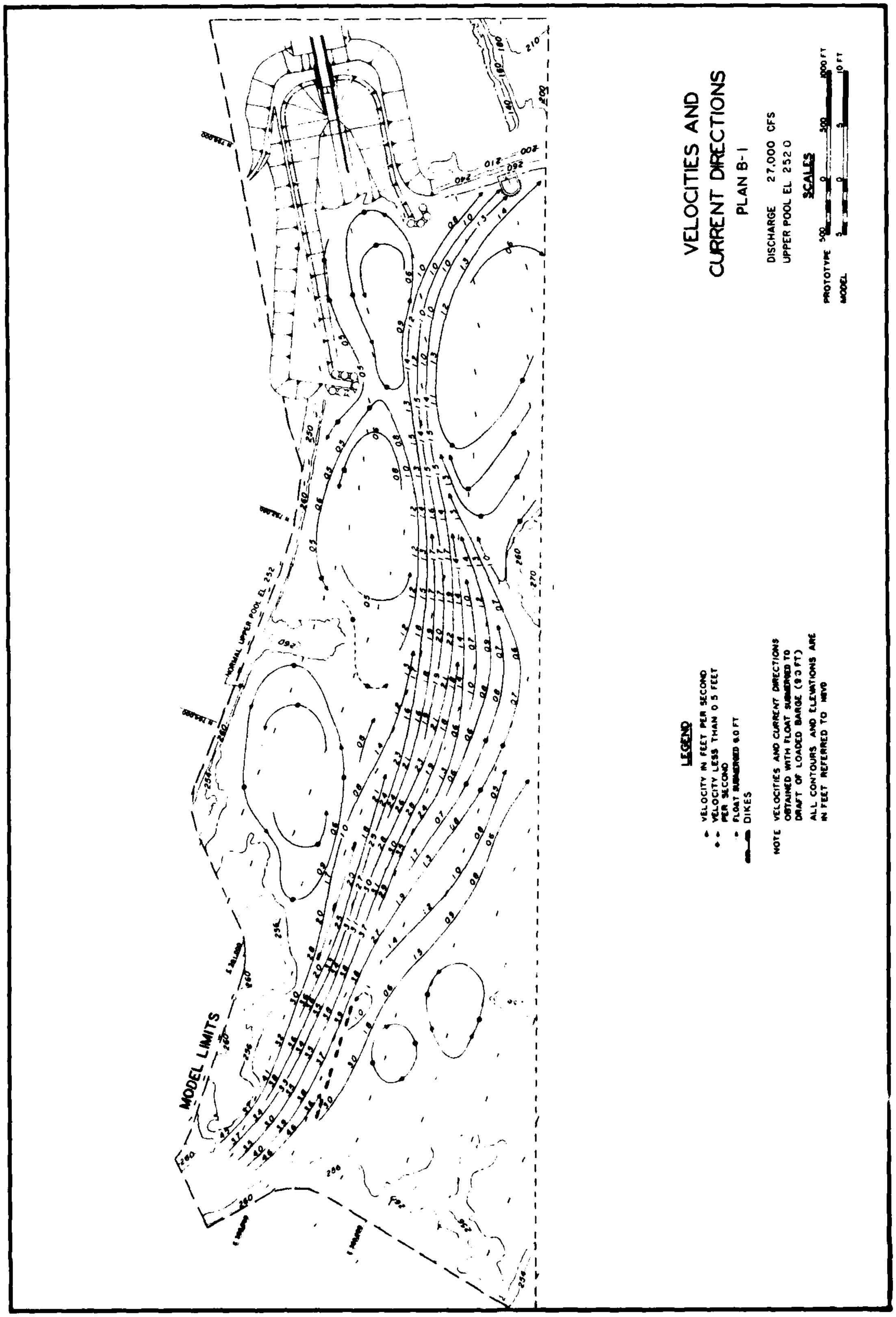
VELOCITIES AND CURRENT DIRECTIONS

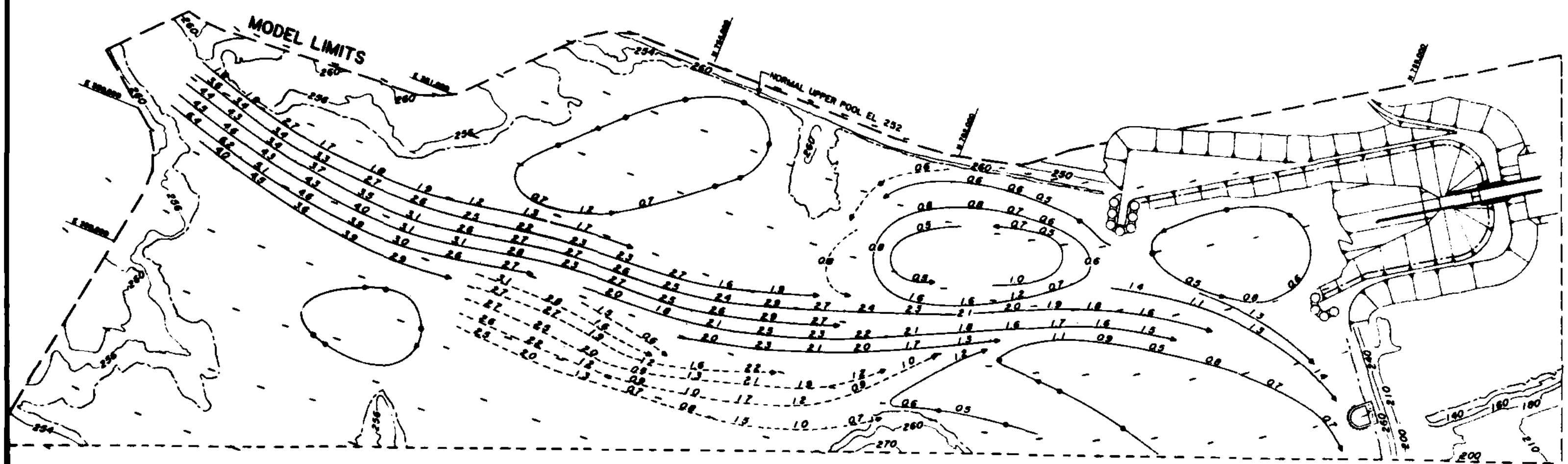
PLAN B-1

DISCHARGE 27,000 CFS
UPPER POOL EL 248.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT


VELOCITIES AND
CURRENT DIRECTIONS
PLAN B-1
DISCHARGE 27,000 CFS
UPPER POOL EL 252.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
FLOAT SUBMERGED 9.0 FT
DIKES
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
NORMAL UPPER POOL EL 252
MODEL LIMITS



LEGEND

- → VELOCITY IN FEET PER SECOND
- →•→ VELOCITY LESS THAN 0.5 FEET PER SECOND
- - - -→ FLOAT SUBMERGED 6.0 FT

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (6.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

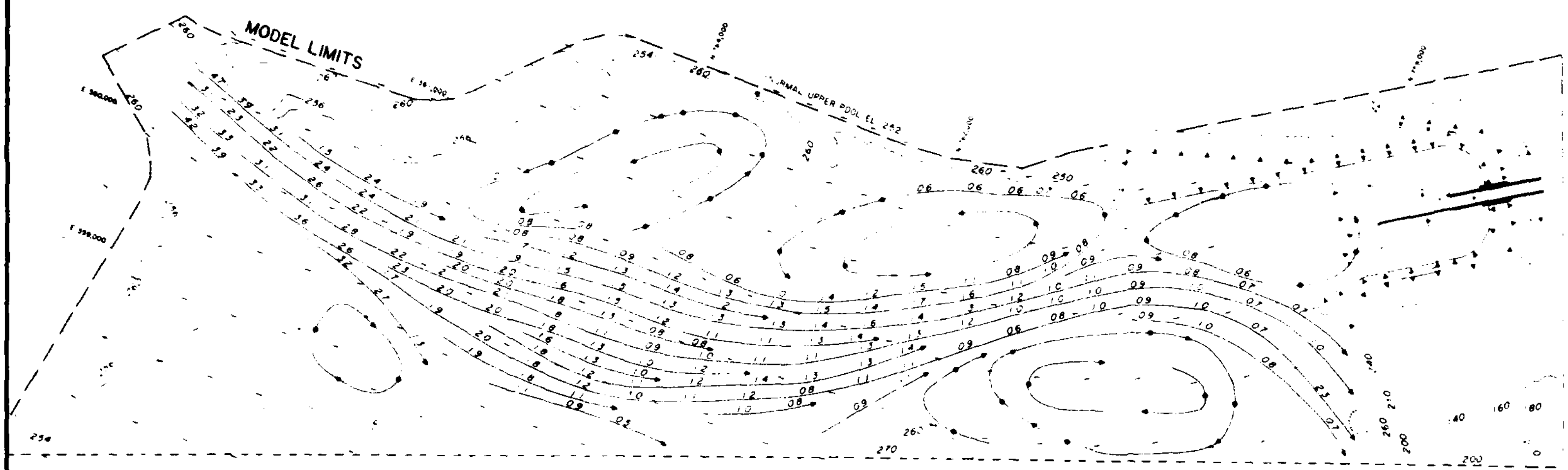
VELOCITIES AND CURRENT DIRECTIONS

PLAN B-2

DISCHARGE 27,000 CFS
UPPER POOL EL 248.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN B-2

DISCHARGE 27,000 CFS
UPPER POOL EL 252.0

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

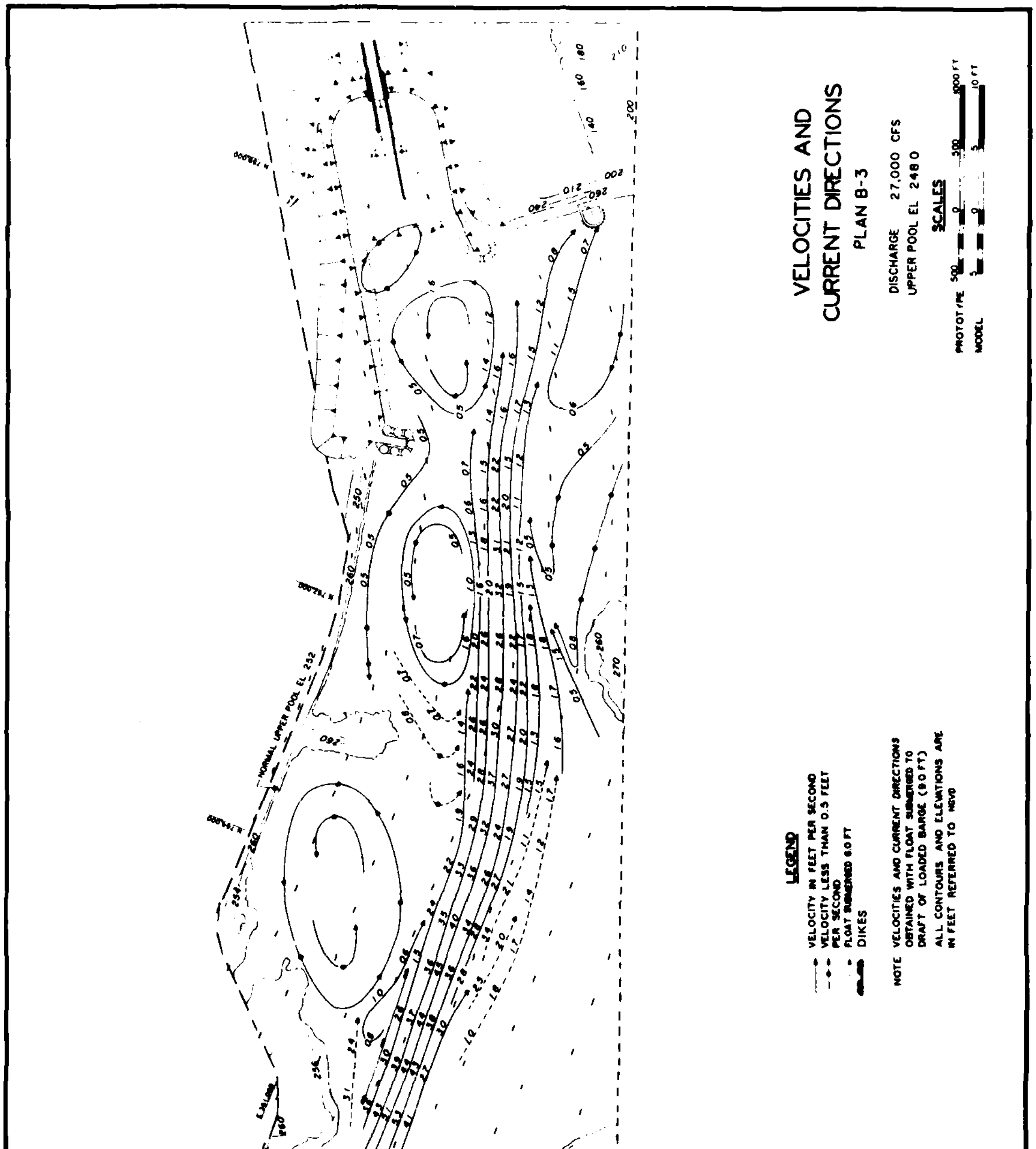
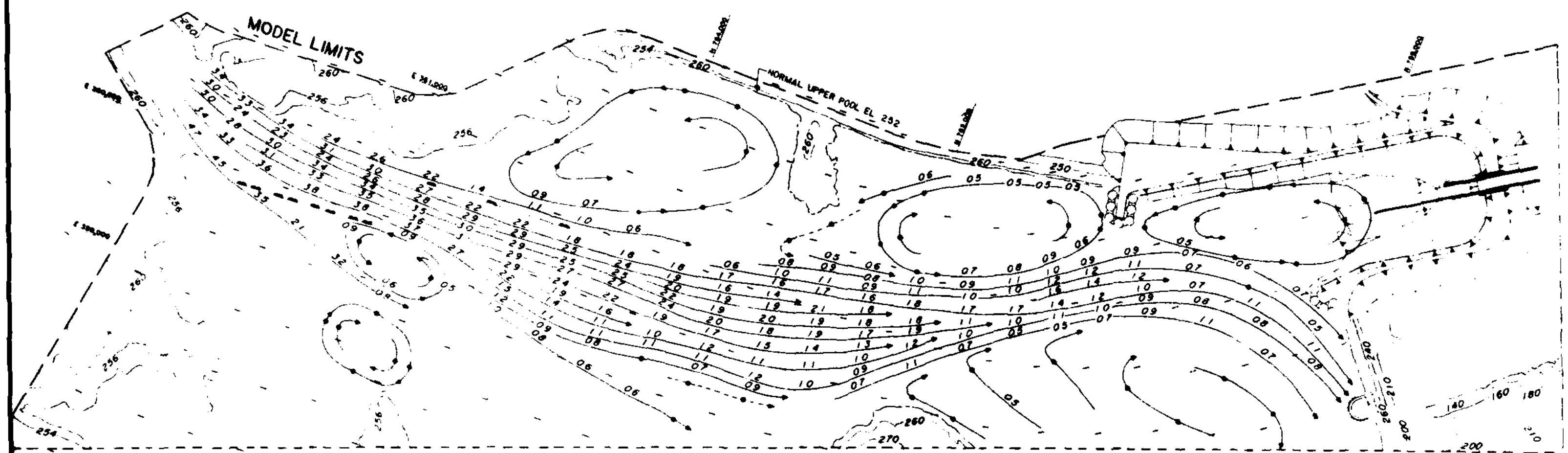

VELOCITIES AND
CURRENT DIRECTIONS
PLAN B-3
DISCHARGE 27,000 CFS
UPPER POOL EL 248.0
SCALES
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
FLOAT SUBMERGED 6.0 FT
DIKES
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
NORMAL UPPER POOL EL 252

PLATE 48



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- FLOAT SUBMERGED 6.0 FT
- DIKES

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

PLAN B-3

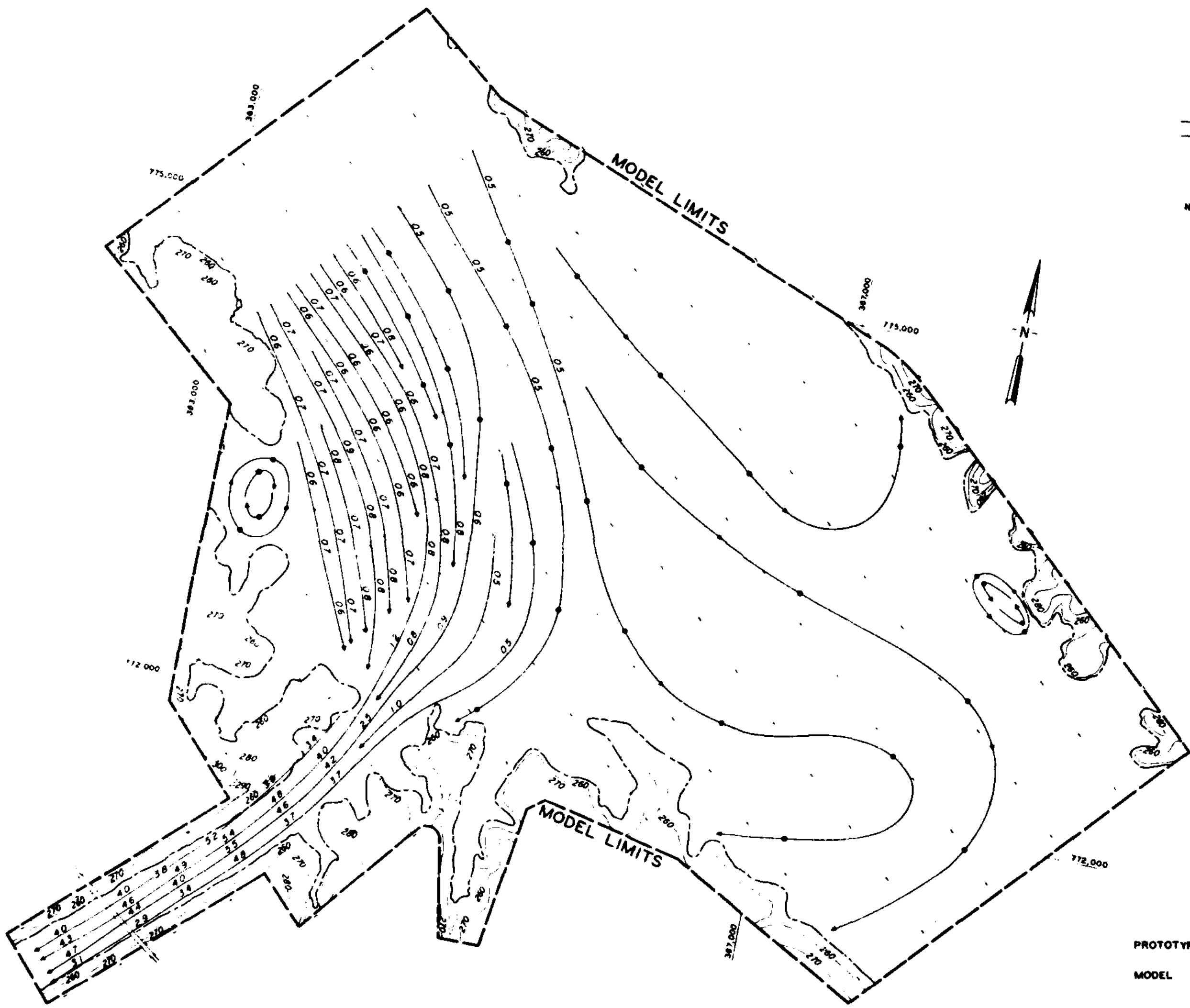
DISCHARGE 27,000 CFS

UPPER POOL EL 252.0

SCALES

PROTOTYPE 500 0 500 1000 FT

MODEL 5 0 5 10 FT



LEGEND

→ VELOCITY IN FEET PER SECOND

•→ VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

JORDAN DAM	-0-	CFS
DIVERSION CANAL	27,000	CFS
TOTAL DISCHARGE	27,000	CFS
UPPER POOL EL	248.0	

SCALES

PROTOTYPE 500 0 500 1000 FT

MODEL 5 0 5 10 FT

PLATE 50

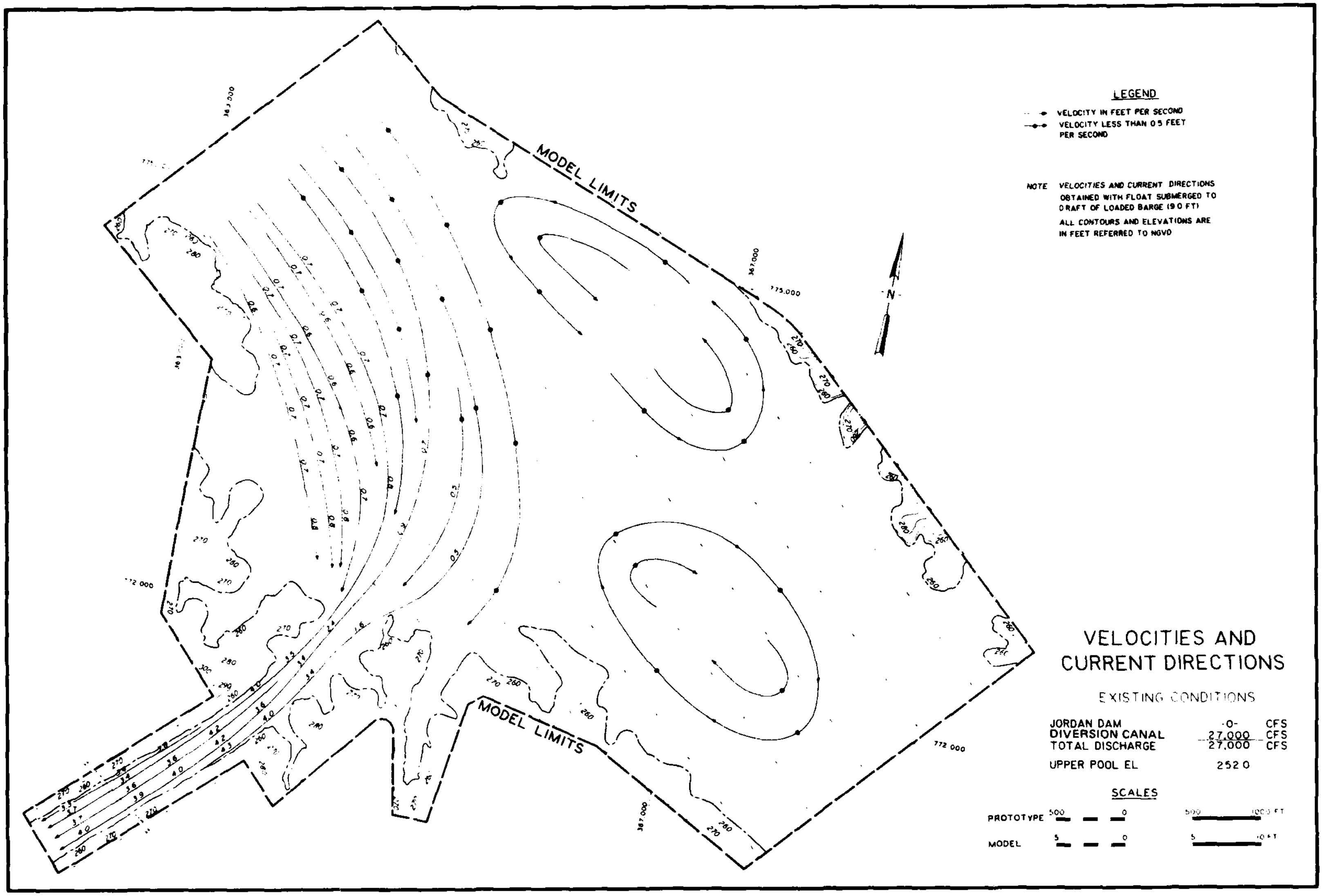

LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
N
VELOCITIES AND CURRENT DIRECTIONS
EXISTING CONDITIONS
JORDAN DAM -0- CFS
DIVERSION CANAL 27,000 CFS
TOTAL DISCHARGE 27,000 CFS
UPPER POOL EL 252.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 51

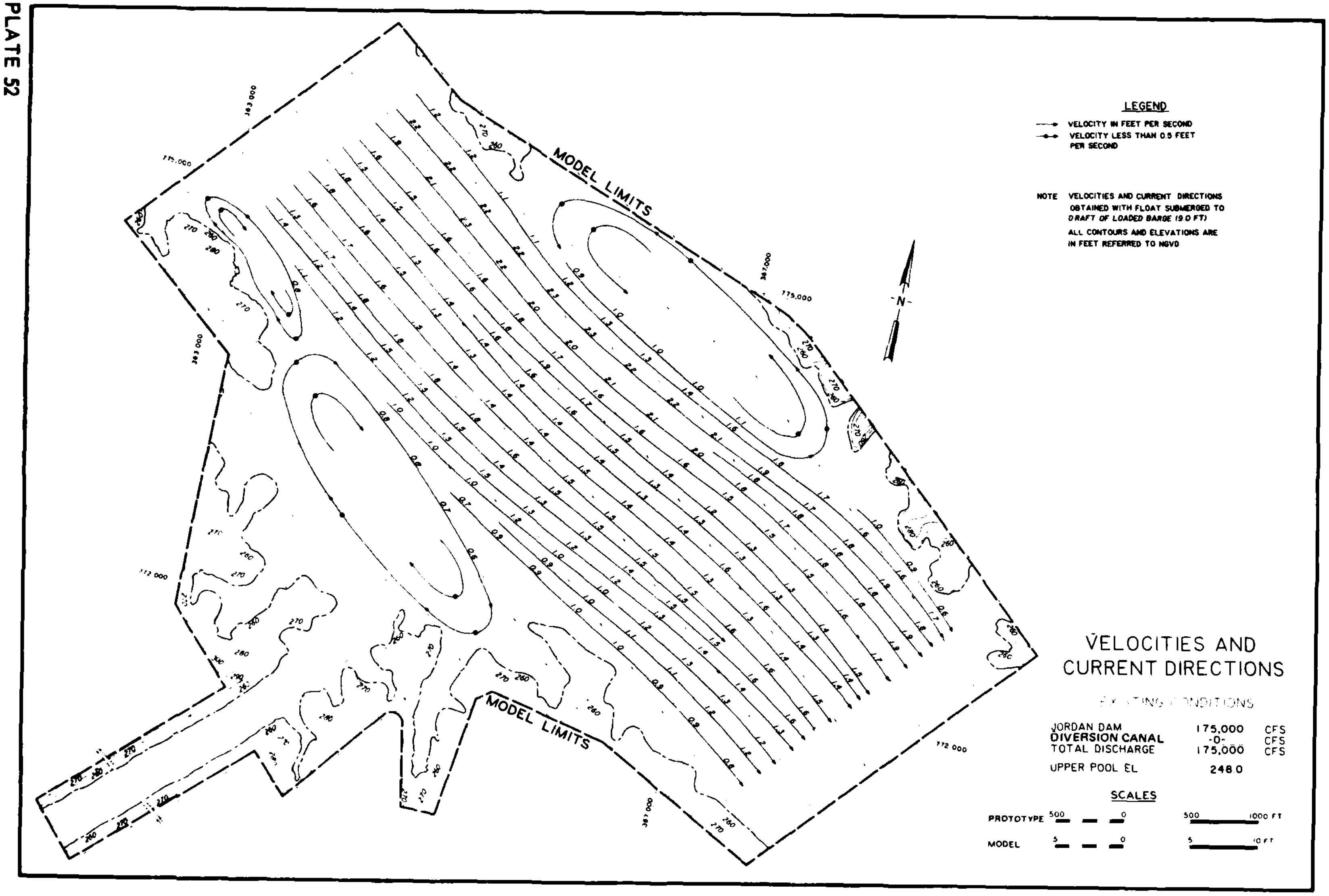
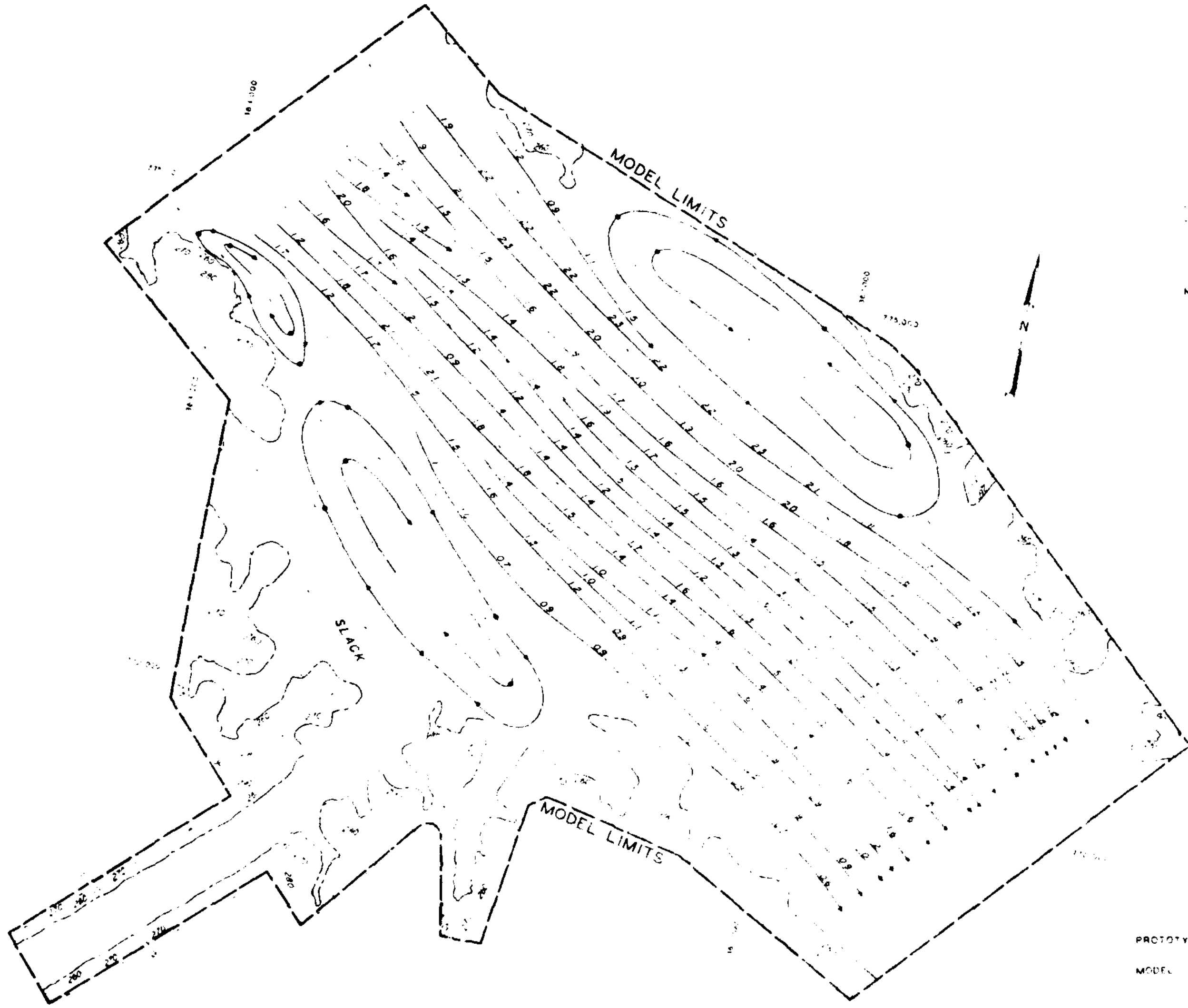

LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
N
VELOCITIES AND CURRENT DIRECTIONS
JORDAN DAM 175,000 CFS
DIVERSION CANAL -0- CFS
TOTAL DISCHARGE 175,000 CFS
UPPER POOL EL 248.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 52



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

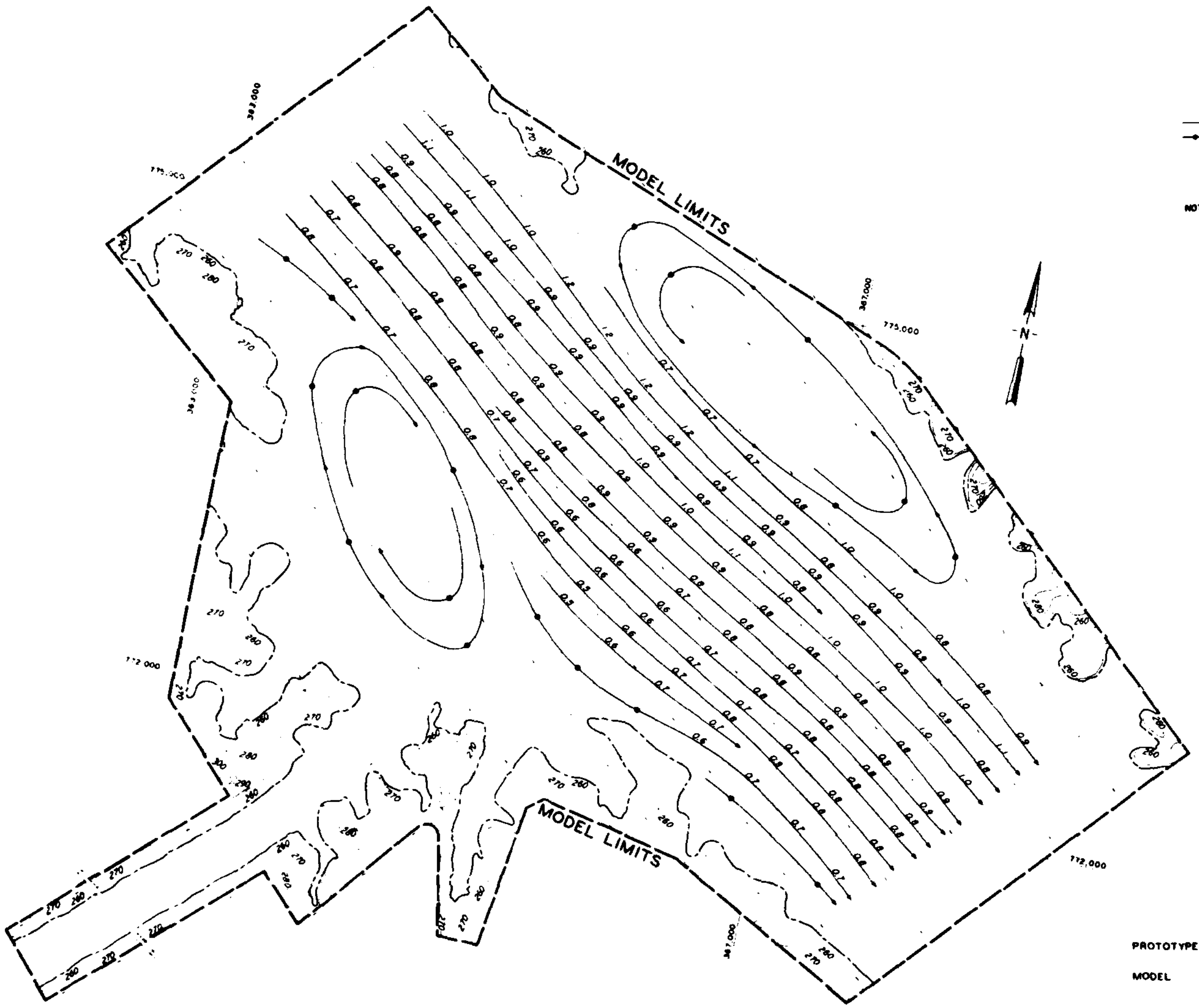
VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

JORDAN DAM	175,000	CFS
DIVERSION CANAL	-0-	CFS
TOTAL DISCHARGE	175,000	CFS
UPPER POOL EL	252.0	

SCALES

PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

JORDAN DAM	90,000	CFS
DIVERSION CANAL	-0-	CFS
TOTAL DISCHARGE	90,000	CFS
UPPER POOL EL	248.0	

SCALES

PROTOTYPE 500 0 500 1000 FT

MODEL 5 0 5 10 FT

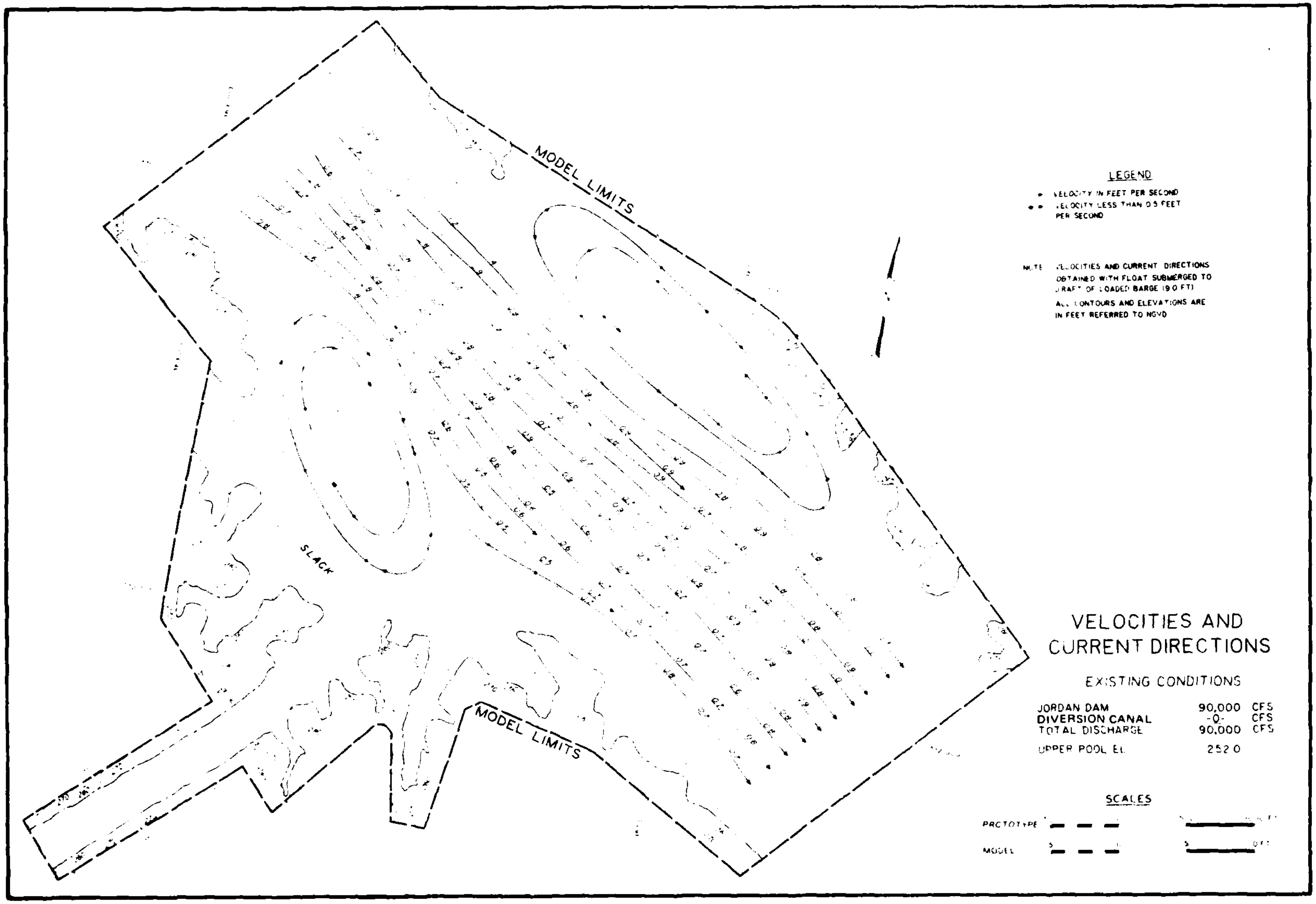

LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
SLACK
VELOCITIES AND CURRENT DIRECTIONS
EXISTING CONDITIONS
JORDAN DAM 90,000 CFS
DIVERSION CANAL -0- CFS
TOTAL DISCHARGE 90,000 CFS
UPPER POOL EL 252.0
SCALES
PROTOTYPE
MODEL

PLATE 55

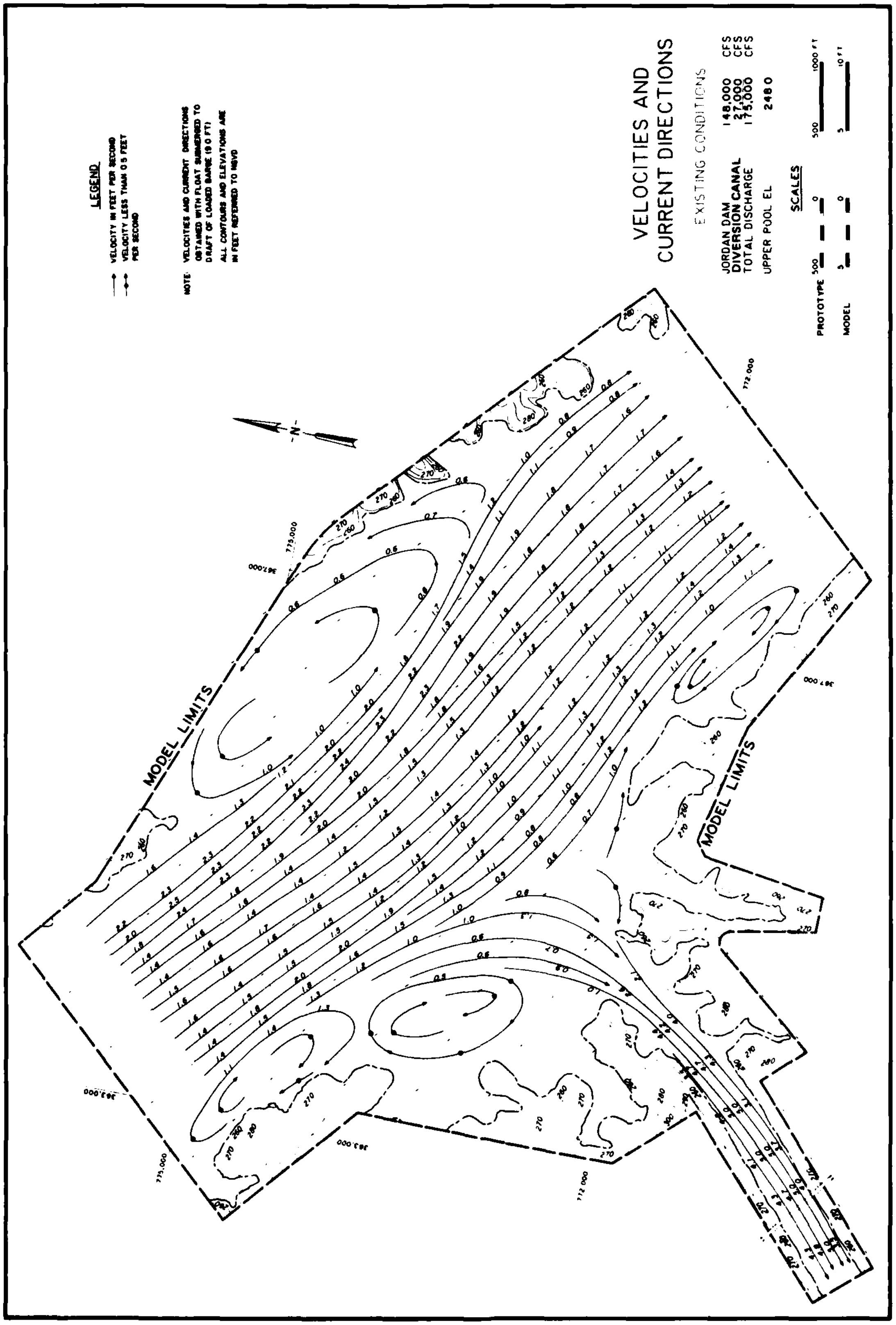
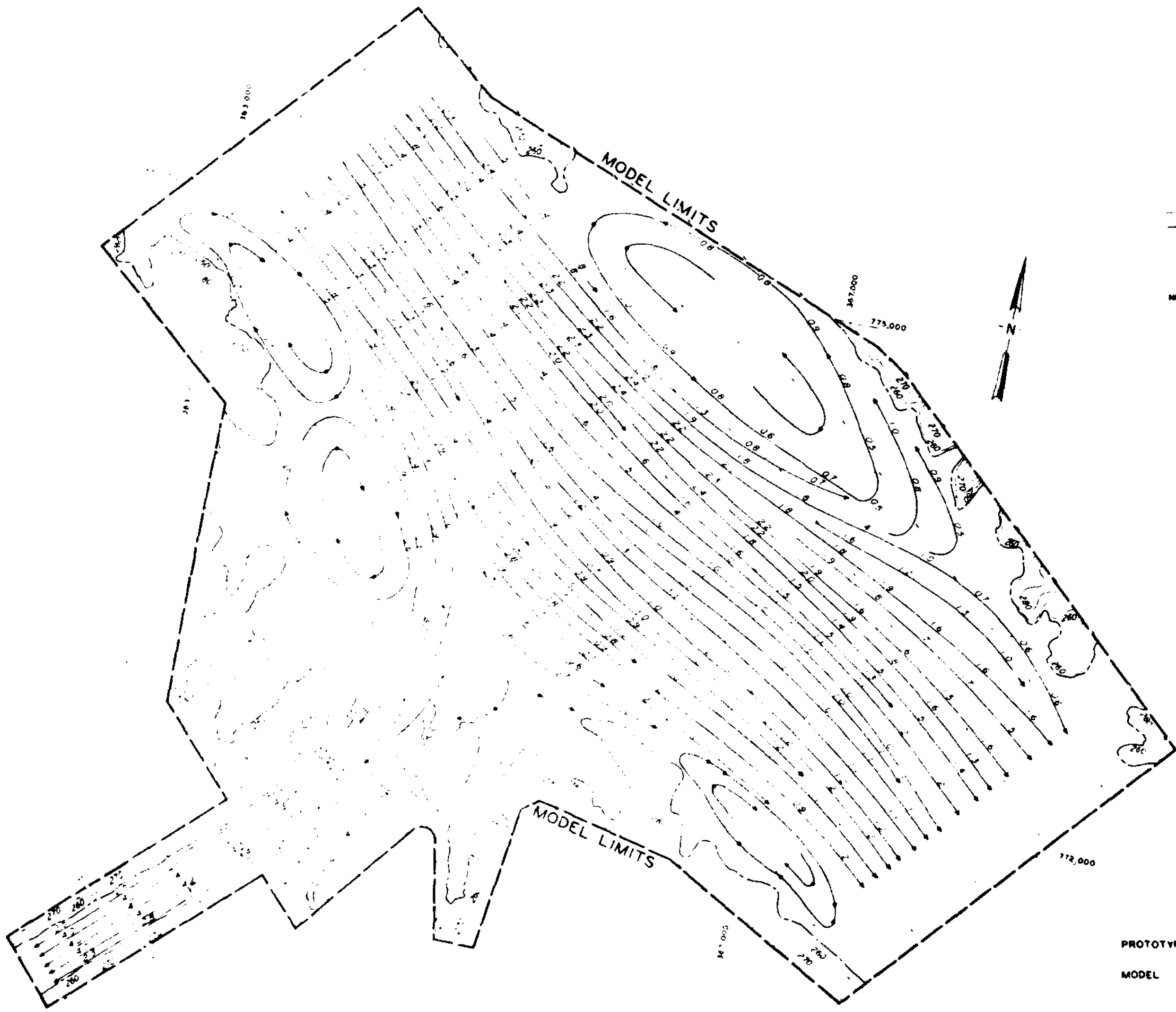

VELOCITIES AND
CURRENT DIRECTIONS
EXISTING CONDITIONS
JORDAN DAM 148,000 CFS
DIVERSION CANAL 27,000 CFS
TOTAL DISCHARGE 175,000 CFS
UPPER POOL EL 248.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
MODEL LIMITS
MODEL LIMITS
N

PLATE 56



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT). ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

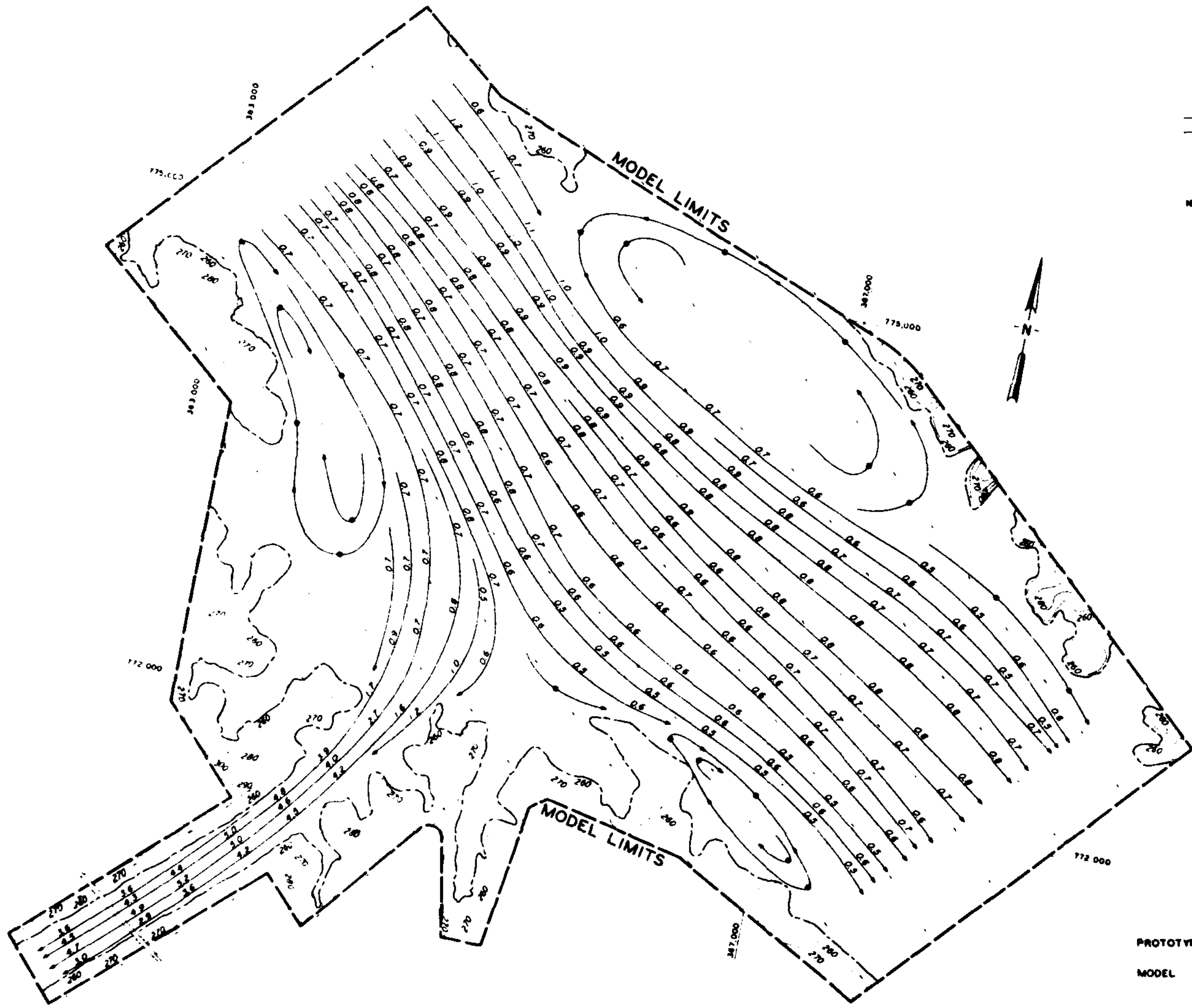
EXISTING CONDITIONS

JORDAN DAM	148,000 CFS
DIVERSION CANAL	27,000 CFS
TOTAL DISCHARGE	175,000 CFS
UPPER POOL EL	252.0

SCALES

PROTOTYPE 500 0 500 1000 FT

MODEL 5 0 5 10 FT



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

JORDAN DAM	63,000	CFS
DIVERSION CANAL	27,000	CFS
TOTAL DISCHARGE	90,000	CFS
UPPER POOL EL	248.0	

SCALES

PROTOTYPE 500 0 500 1000 FT

MODEL 5 0 5 10 FT

PLATE 58

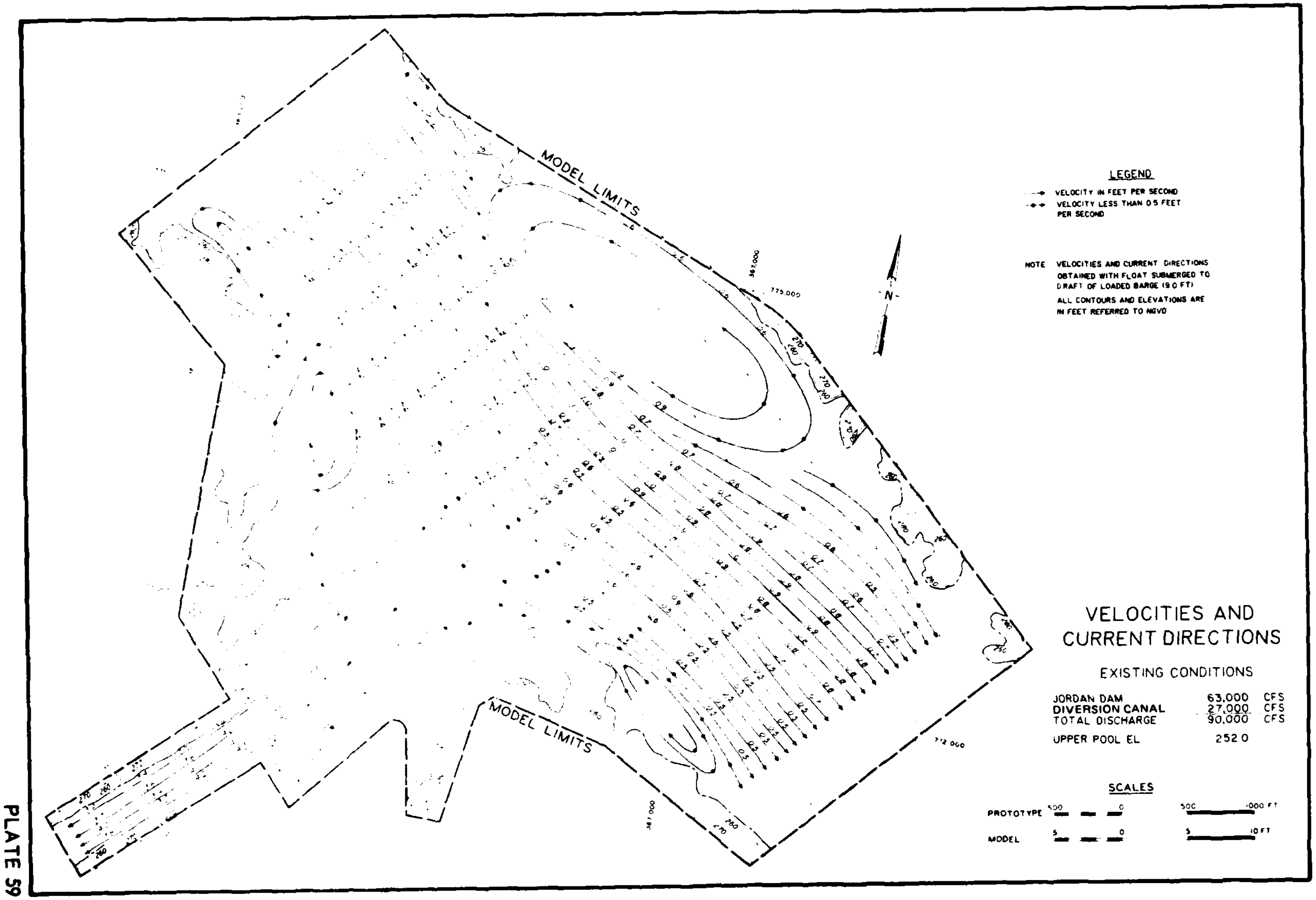
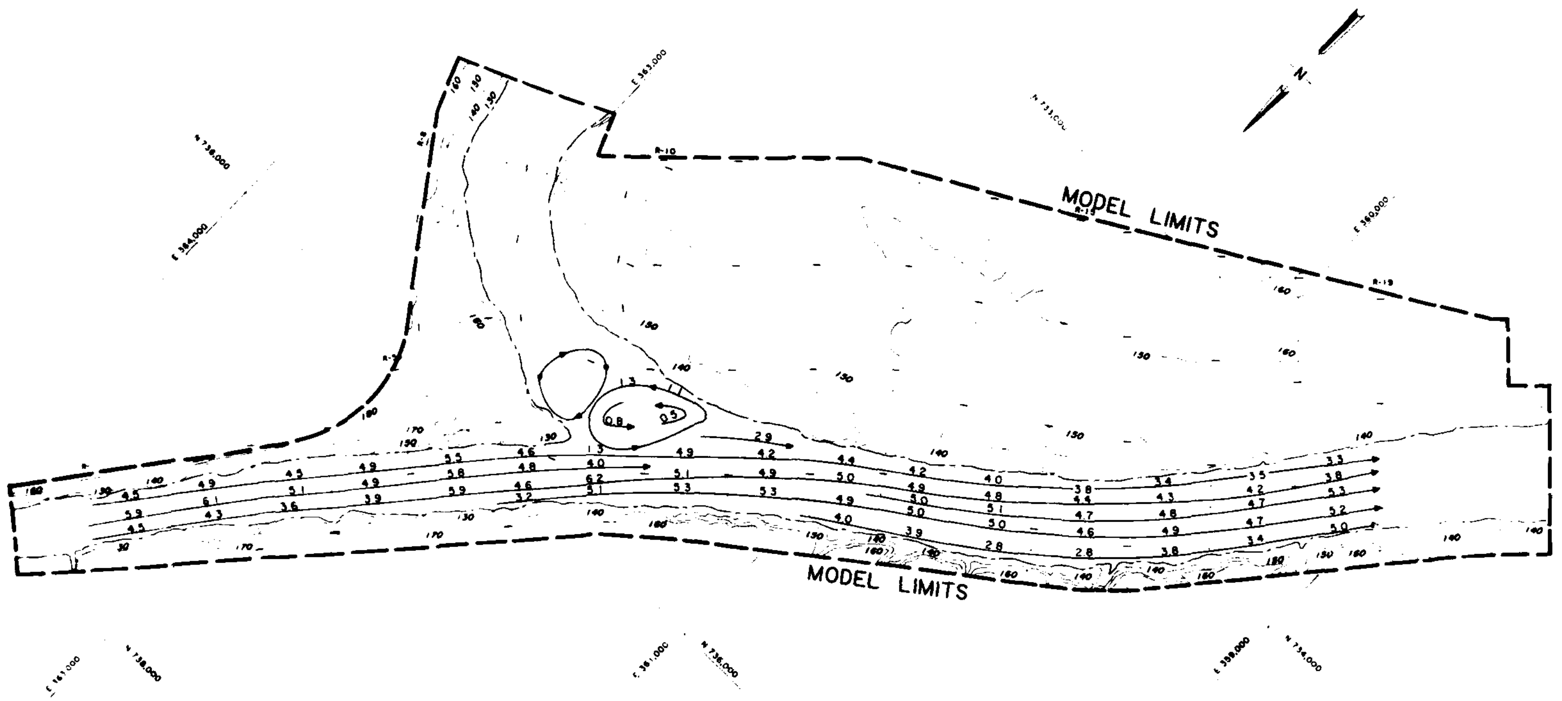

LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
N
MODEL LIMITS
MODEL LIMITS
VELOCITIES AND CURRENT DIRECTIONS
EXISTING CONDITIONS
JORDAN DAM 63,000 CFS
DIVERSION CANAL 27,000 CFS
TOTAL DISCHARGE 90,000 CFS
UPPER POOL EL 252.0
SCALES
PROTOTYPE 500 0 500 1000 FT
MODEL 5 0 5 10 FT

PLATE 59



LEGEND

→ VELOCITY IN FEET PER SECOND
• • VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD.

SCALES

PROTOTYPE

MODEL

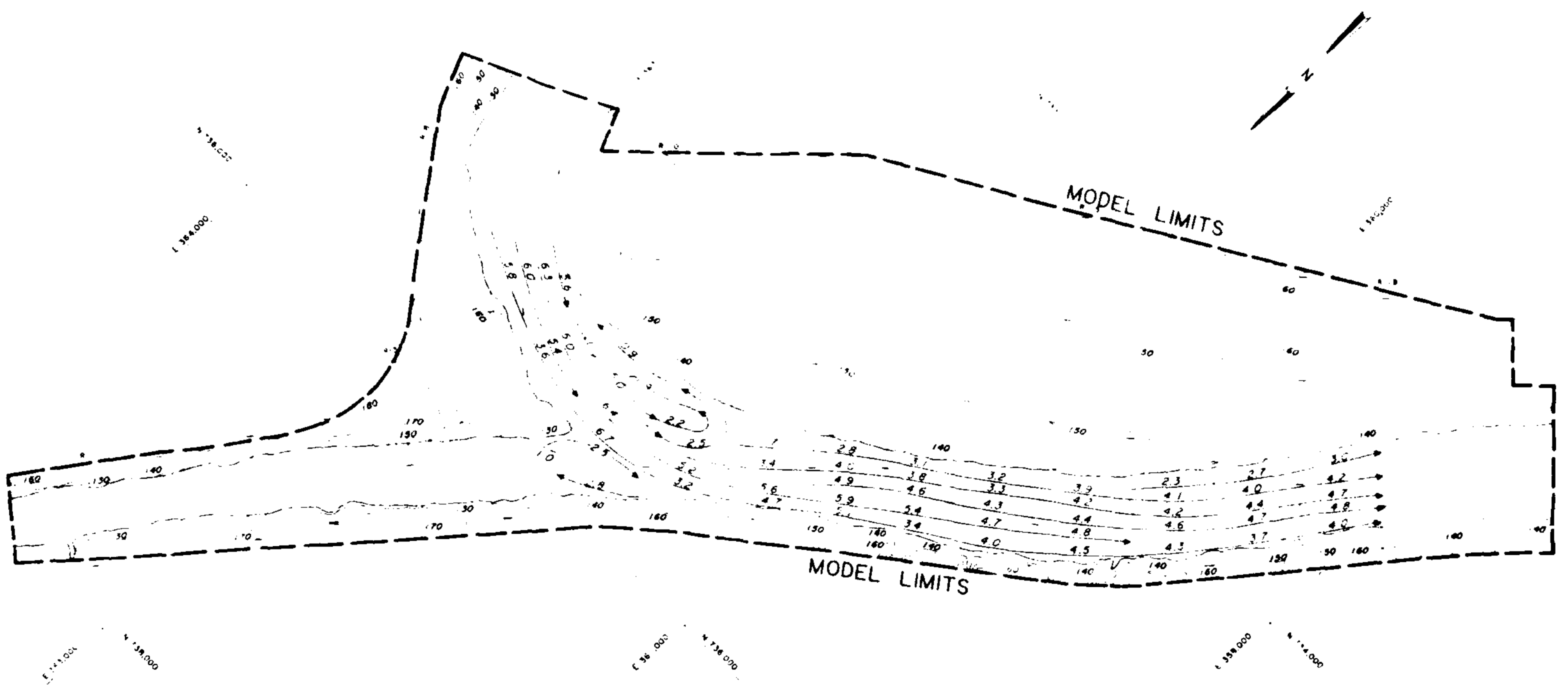
VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

POWERHOUSE	DISCHARGE	27,000	CFS
JORDAN	DISCHARGE	-0-	CFS
TOTAL	DISCHARGE	27,000	CFS

TAILWATER EL. 125.3

PLATE 60



LEGEND

VELOCITY IN FEET PER SECOND

VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE

MODEL

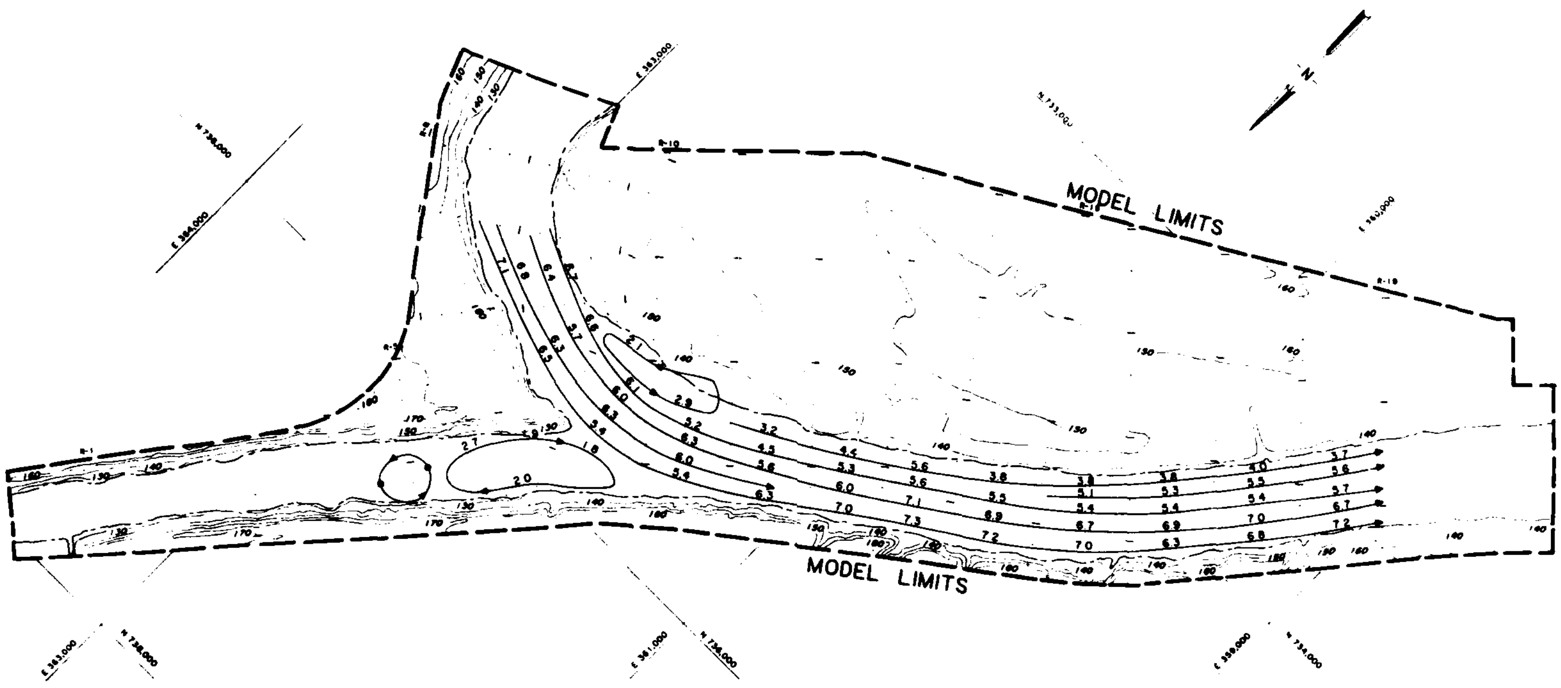
VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

POWERHOUSE	DISCHARGE	-0-	CFS
JORDAN	DISCHARGE	27,000	CFS
TOTAL	DISCHARGE	27,000	CFS

TAILWATER EL 125.3

PLATE 61



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 200 0 200 400

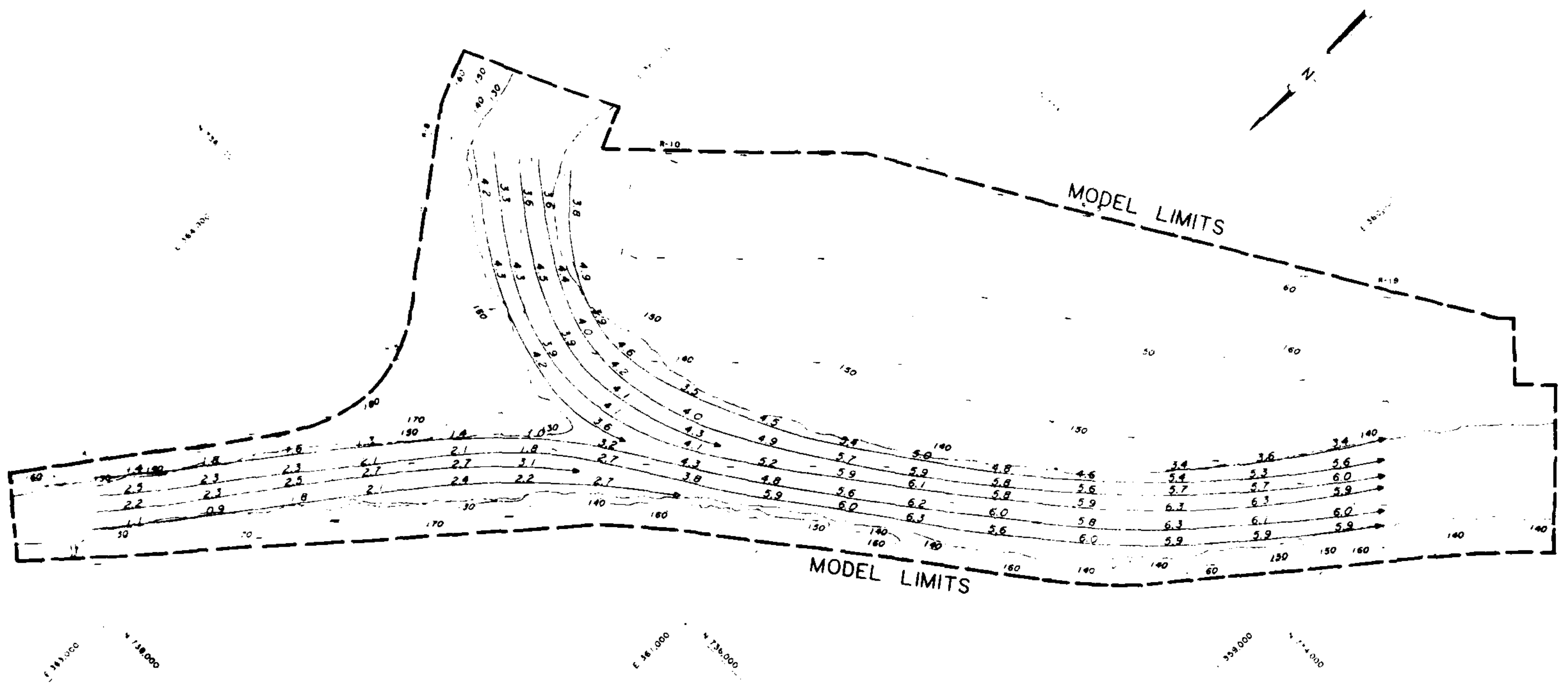
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

POWERHOUSE	DISCHARGE	-0-	CFS
JORDAN	DISCHARGE	60,000	CFS
TOTAL	DISCHARGE	60,000	CFS

TAILWATER EL 137.1



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

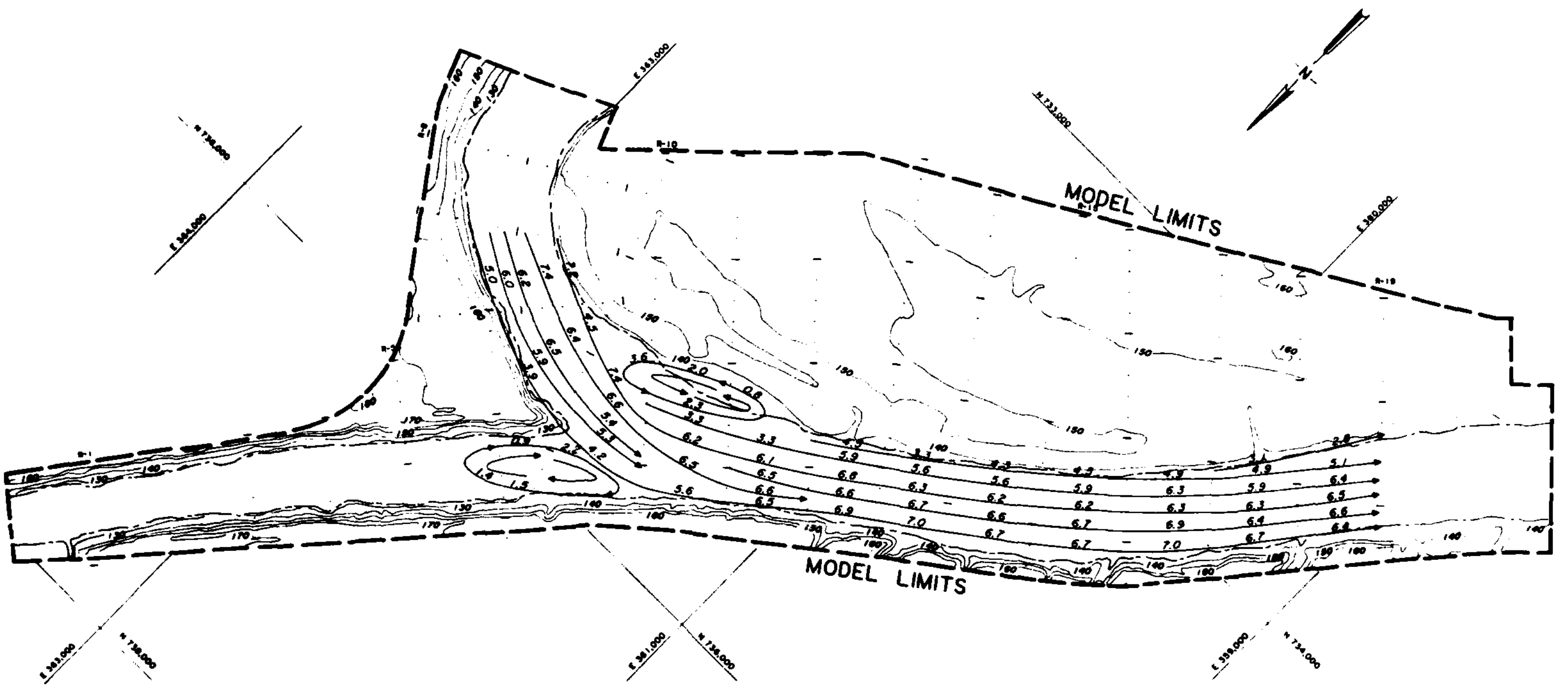
SCALES

PROTOTYPE
MODEL

VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

POWERHOUSE	DISCHARGE	27,000	CFS
JORDAN	DISCHARGE	63,000	CFS
TOTAL	DISCHARGE	90,000	CFS
TAILWATER EL		147.1	



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 200 0 200 400
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

EXISTING CONDITIONS

POWERHOUSE	DISCHARGE	-0-	CFS
JORDAN	DISCHARGE	90,000	CFS
TOTAL	DISCHARGE	90,000	CFS
TAILWATER EL		147.1	

PLATE 64

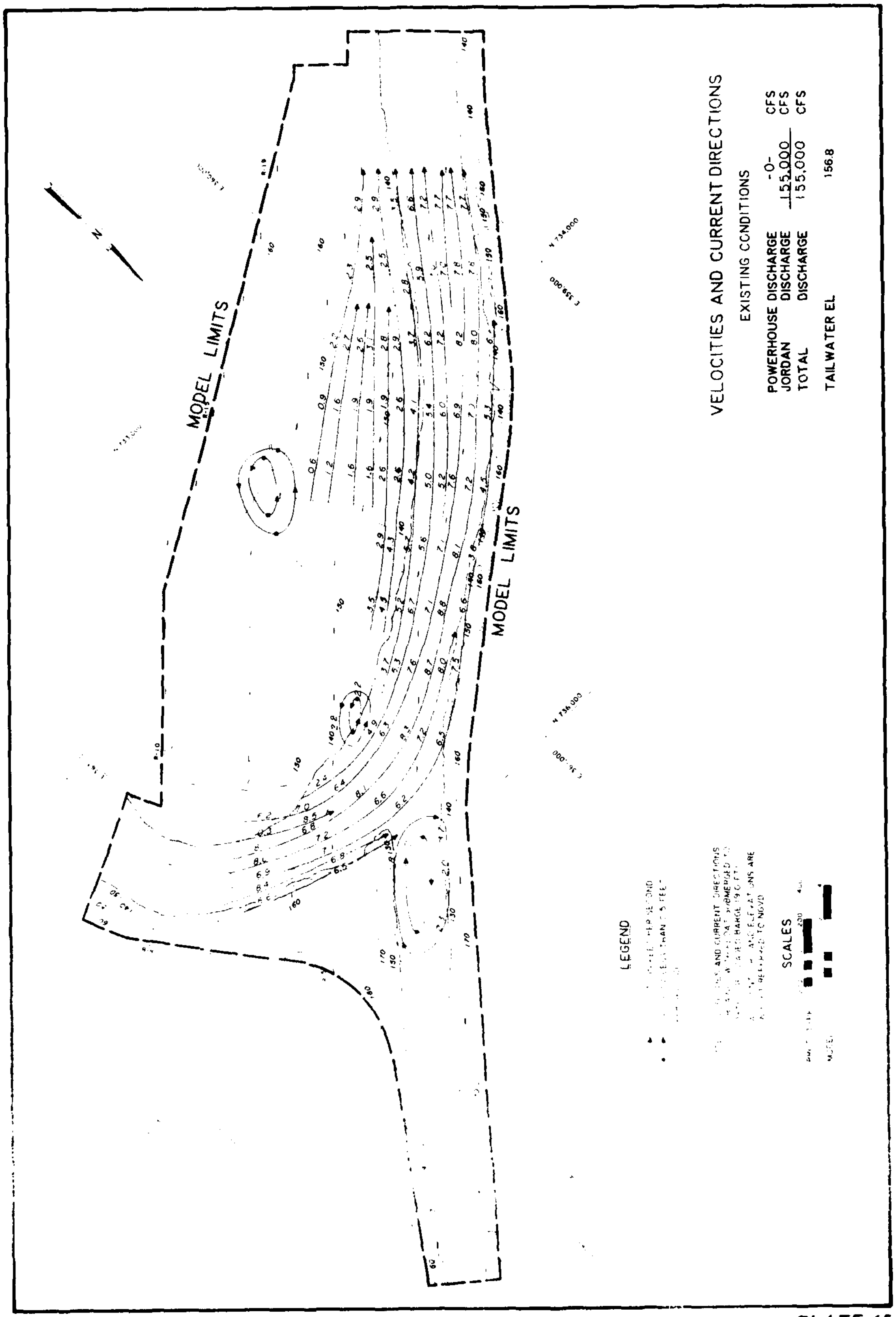
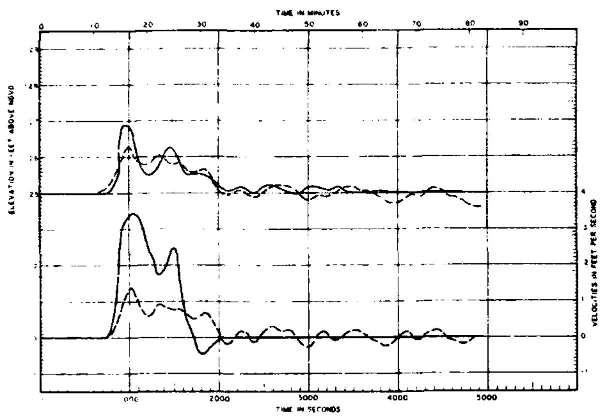
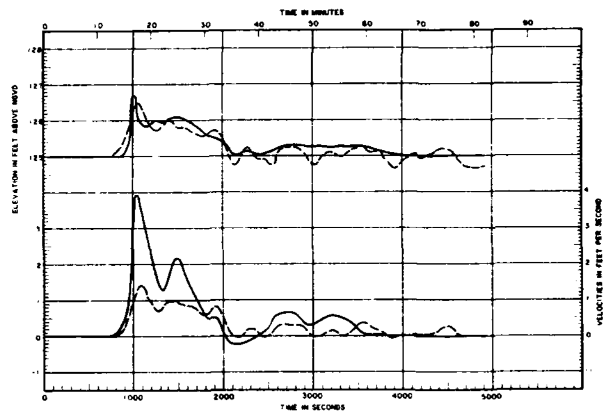

VELOCITIES AND CURRENT DIRECTIONS
EXISTING CONDITIONS
POWERHOUSE DISCHARGE -0- CFS
JORDAN DISCHARGE 155,000 CFS
TOTAL DISCHARGE 155,000 CFS
TAILWATER EL 156.8
MODEL LIMITS
MODEL LIMITS
LEGEND
SCALES

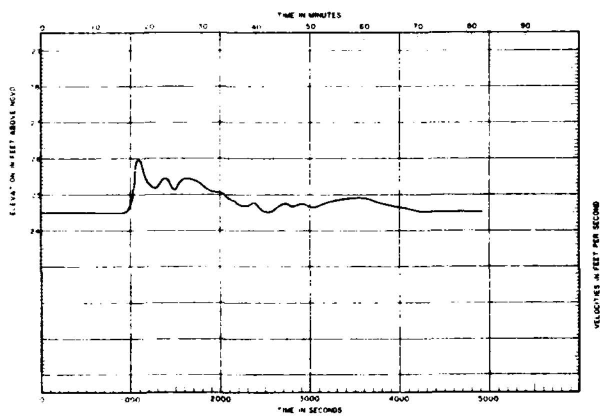
PLATE 65



STATION 1



STATION 2



STATION 3

LEGEND

—— MODEL DATA

- - - COMPUTED DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 1

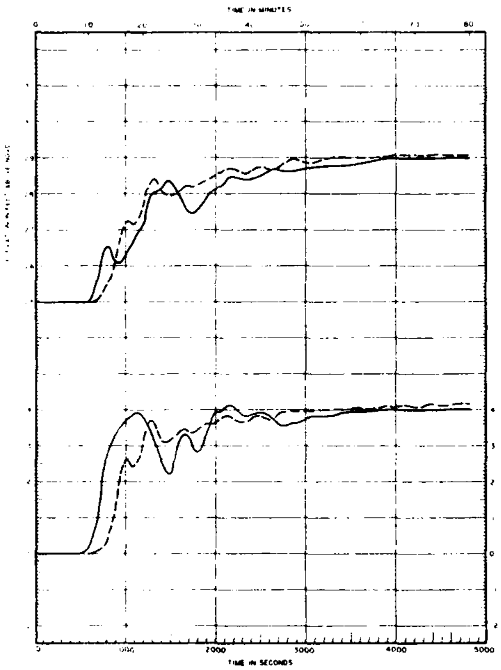
VELOCITIES AND SURGES

EXISTING CONDITIONS

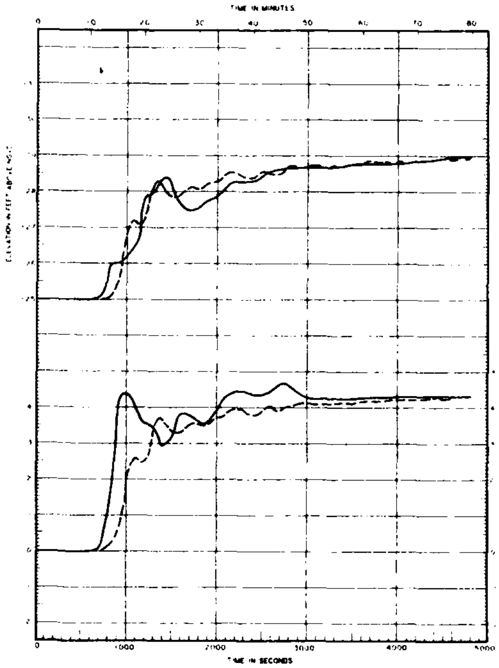
LOCK EMPTYING

RIVER DISCHARGE	27,000 CFS
POWERHOUSE DISCHARGE	0 CFS
INITIAL TAILWATER EL	125.0

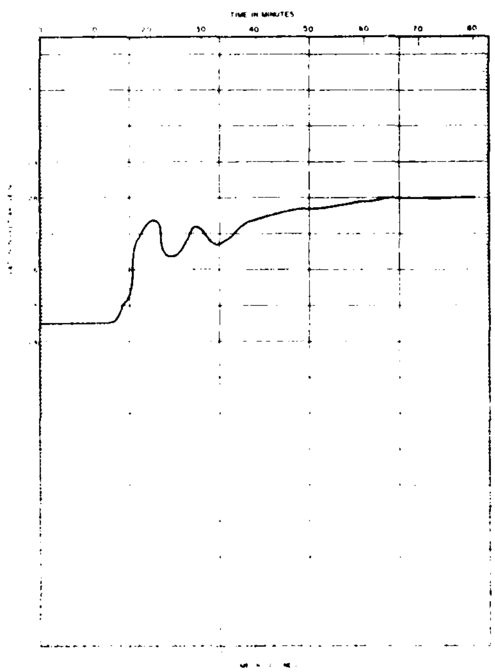
PLATE 66



STATION 1



STATION 2



STATION 3

LEGEND

—— MODEL DATA

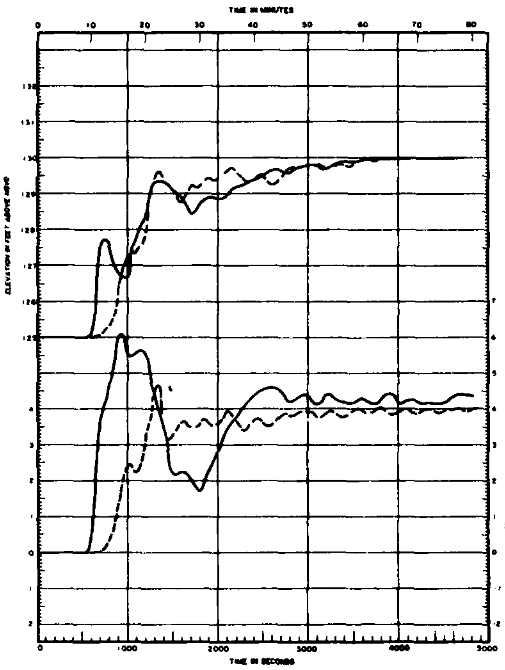
--- COMPUTED DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 1.

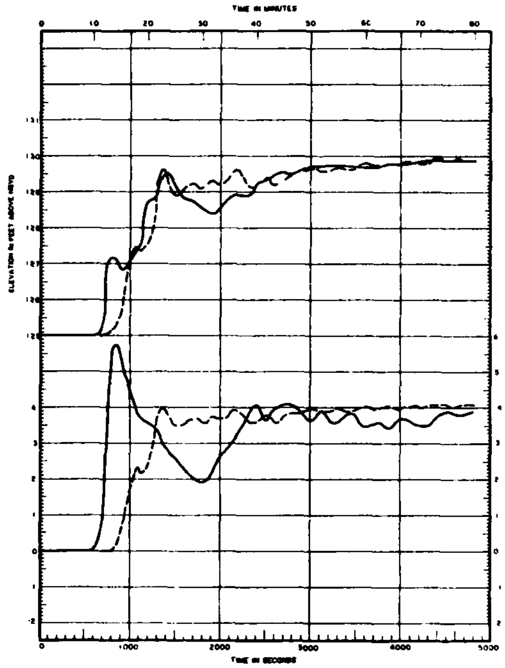
VELOCITIES AND SURGES

[illegible]

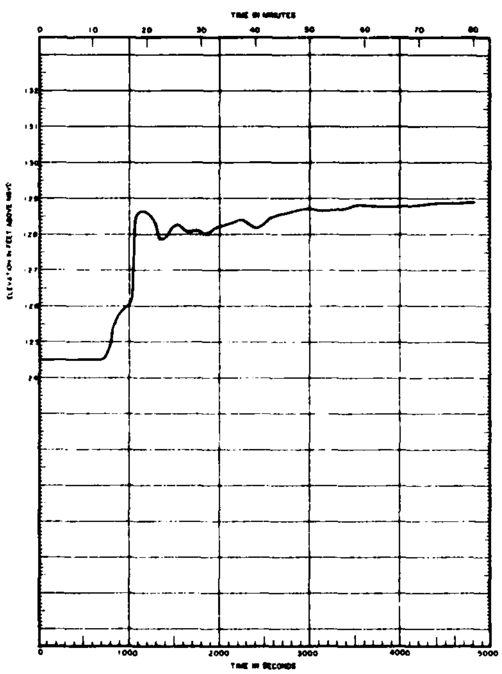
POWERHOUSE DISCHARGE	0-27,000 CFS
RIVER DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	125.0



STATION 1



STATION 2



STATION 3

LEGEND

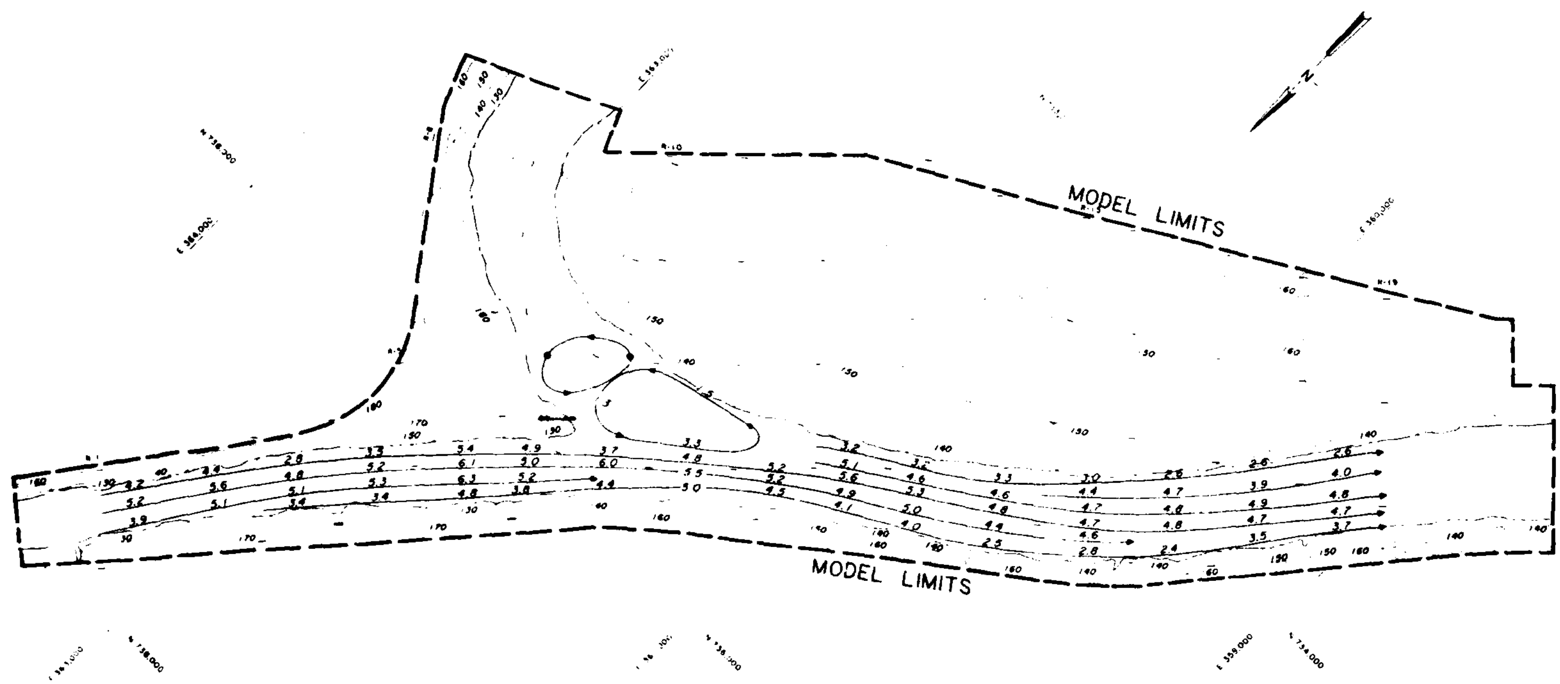
—— MODEL DATA
--- COMPUTED DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 1.

VELOCITIES AND SURGES

EXISTING CONDITIONS

POWERHOUSE DISCHARGE	0-27,000 CFS
SIMULTANEOUS LOCK EMPTYING	
RIVER DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	125.0



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
DIKE

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT).
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

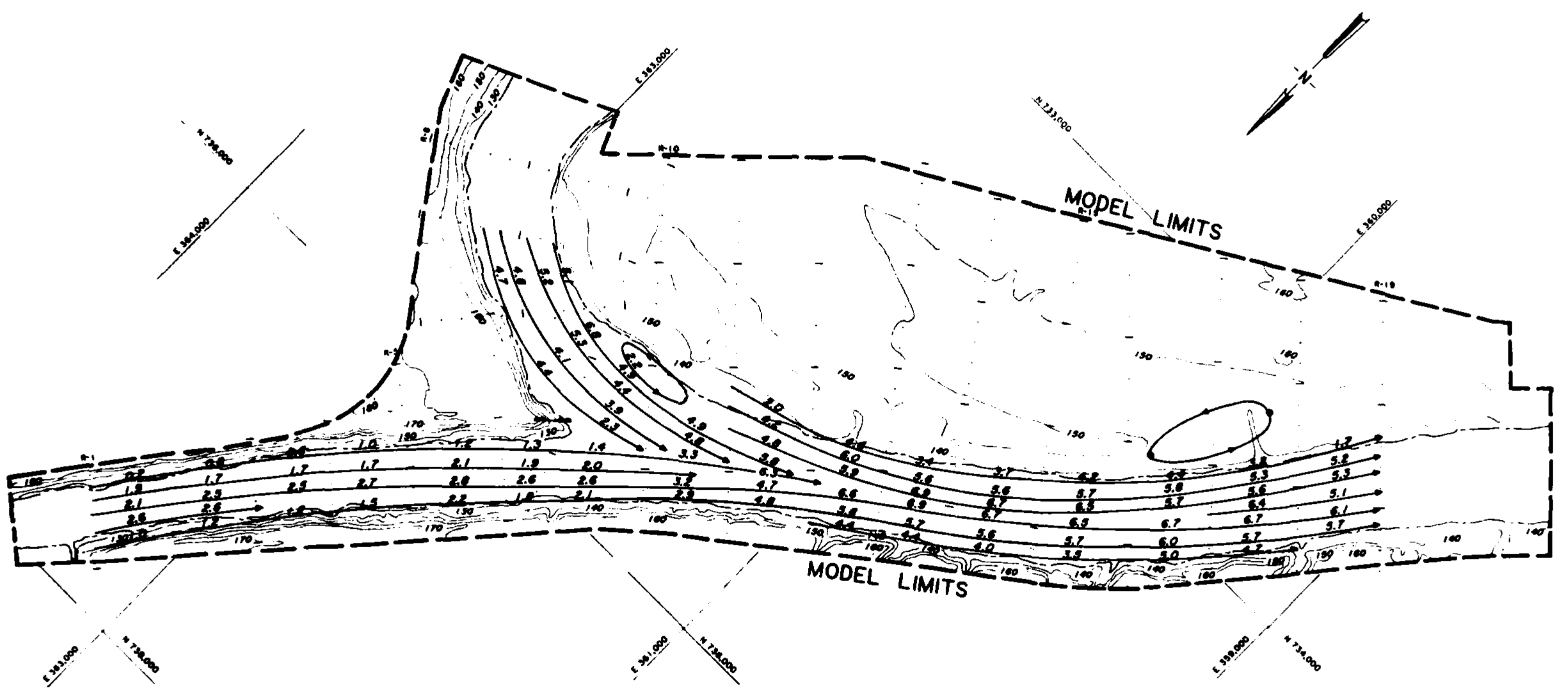
PROTOTYPE 200 0 200 400
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

POWERHOUSE	DISCHARGE	27,000	CFS
JORDAN	DISCHARGE	0	CFS
TOTAL	DISCHARGE	27,000	CFS
TAILWATER EL		125.3	

PLATE 69



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
DIKE

NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

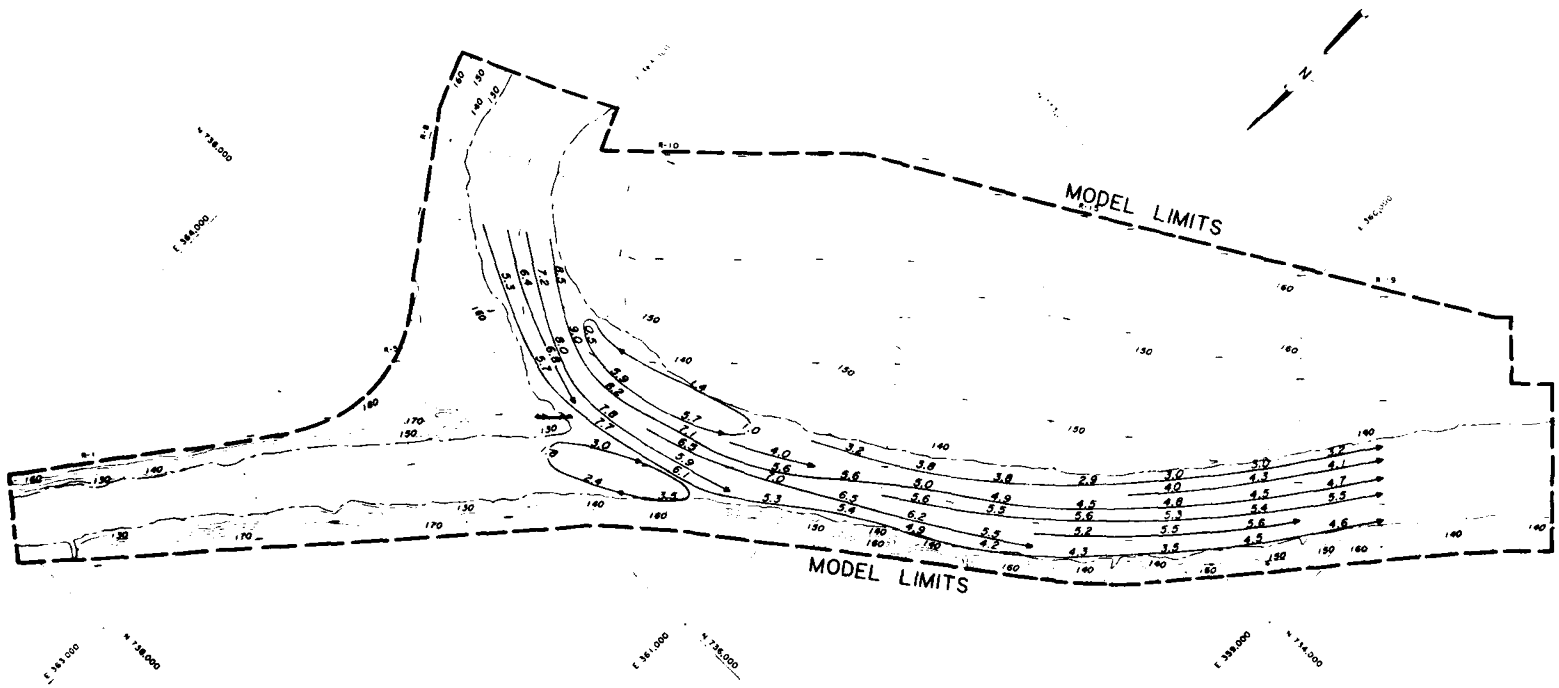
PROTOTYPE 200 0 200 400
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

POWERHOUSE	DISCHARGE	27,000	CFS
JORDAN	DISCHARGE	63,000	CFS
TOTAL	DISCHARGE	90,000	CFS
TAILWATER EL		147.1	

PLATE 70



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
DIKE

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 200 0 200 400
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

POWERHOUSE	DISCHARGE	0	CFS
JORDAN	DISCHARGE	27,000	CFS
TOTAL	DISCHARGE	27,000	CFS

TAILWATER EL 125.3

PLATE 71

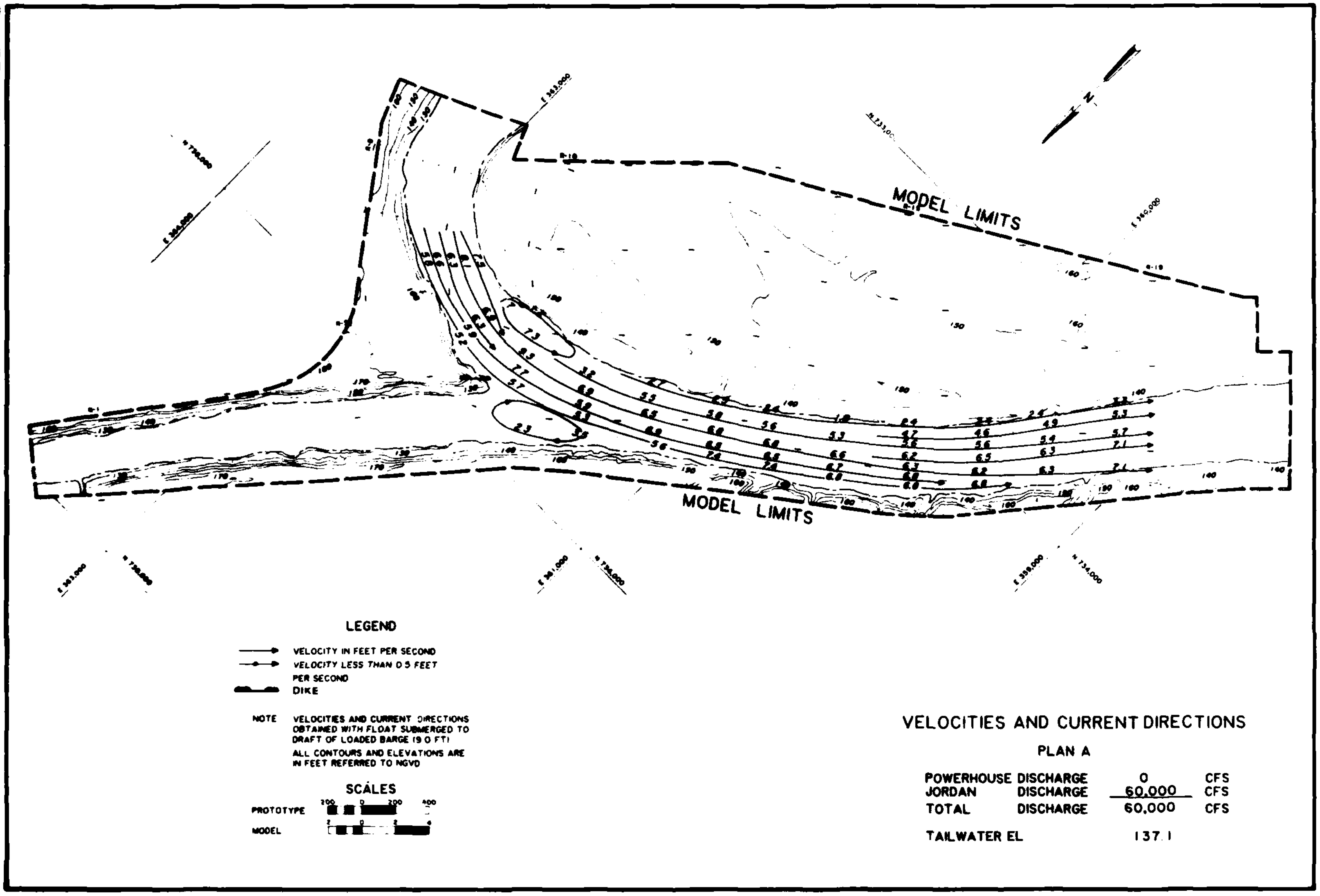
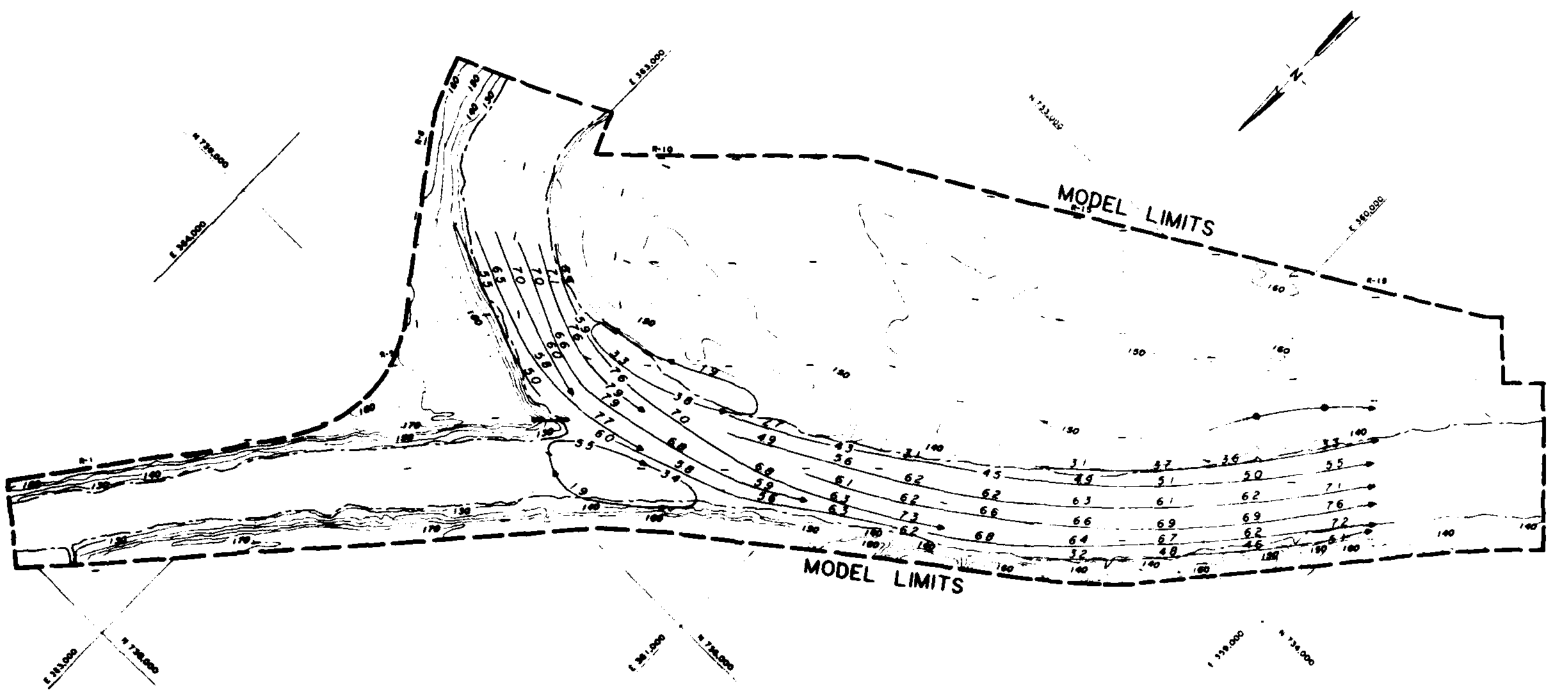

MODEL LIMITS
MODEL LIMITS
N
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
DIKE
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD
SCALES
PROTOTYPE
MODEL
VELOCITIES AND CURRENT DIRECTIONS
PLAN A
POWERHOUSE DISCHARGE 0 CFS
JORDAN DISCHARGE 60,000 CFS
TOTAL DISCHARGE 60,000 CFS
TAILWATER EL 137.1

PLATE 72



LEGEND

- VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- DIKE

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

PROTOTYPE 200 0 200 400

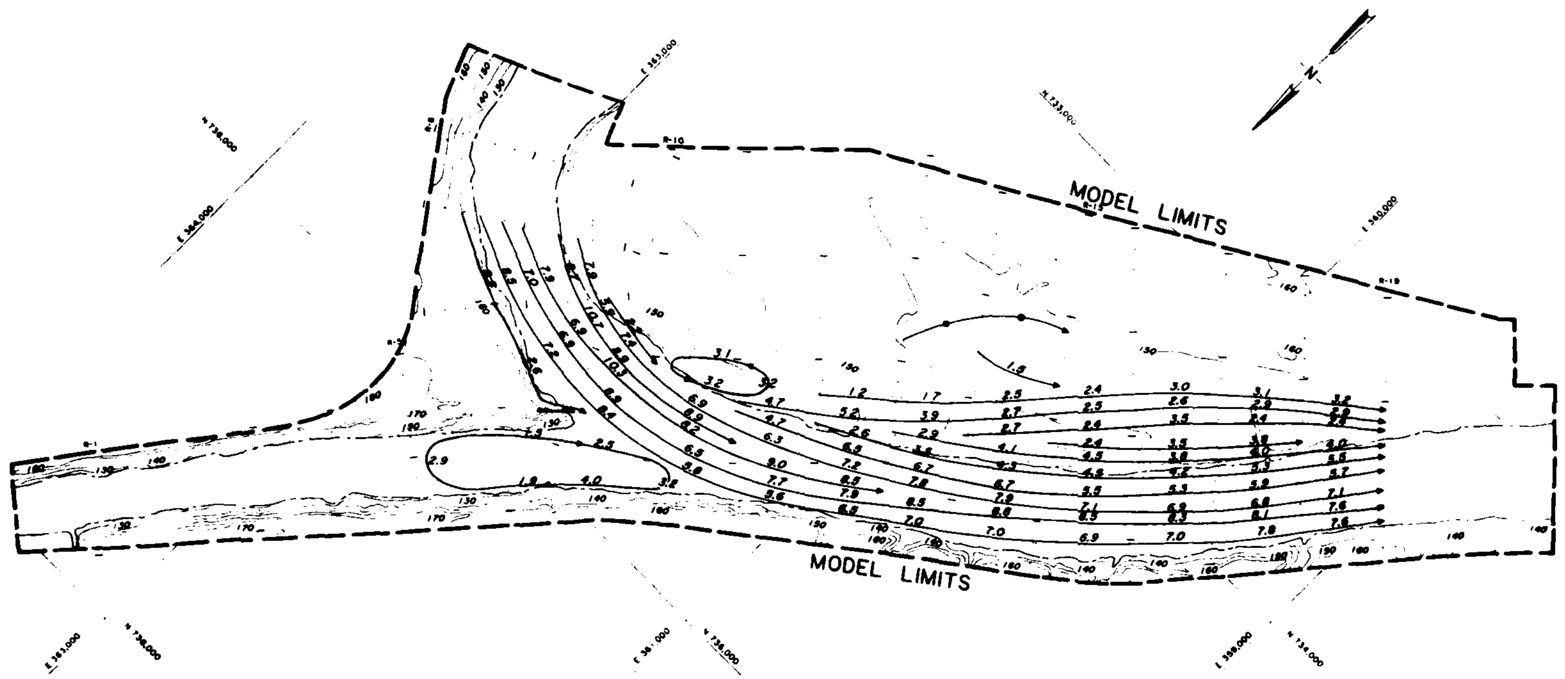
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

PLAN A

POWERHOUSE	DISCHARGE	0	CFS
JORDAN	DISCHARGE	90,000	CFS
TOTAL	DISCHARGE	90,000	CFS
TAILWATER EL		147.1	

PLATE 73



LEGEND

VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
DIKE

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO NGVD

SCALES

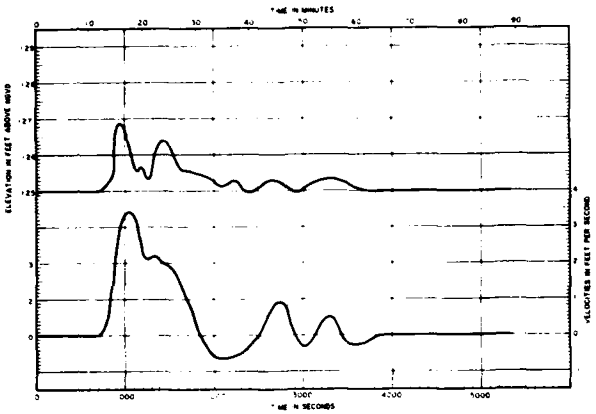
PROTOTYPE 200 0 200 400
MODEL 2 0 2 4

VELOCITIES AND CURRENT DIRECTIONS

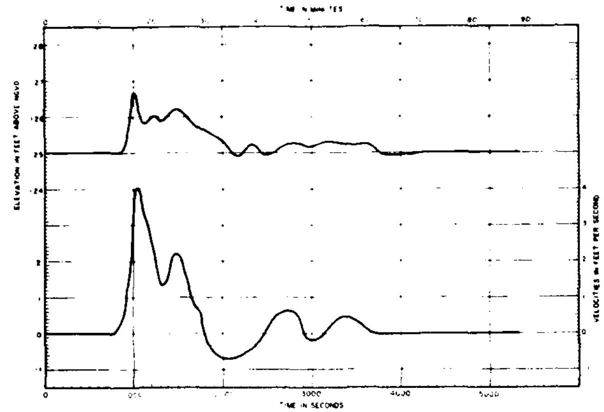
PLAN A

POWERHOUSE	DISCHARGE	0	CFS
JORDAN	DISCHARGE	155,000	CFS
TOTAL	DISCHARGE	155,000	CFS
TAILWATER EL		156.8	

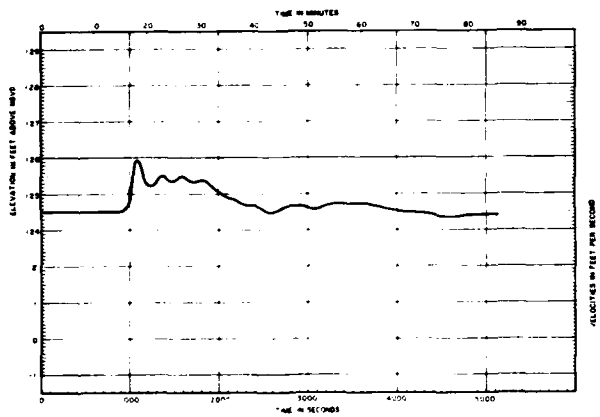
PLATE 74



STATION 1



STATION 2



STATION 3

NOTE: INITIAL TAILWATER EL AT GAGE NO. 1

LEGEND

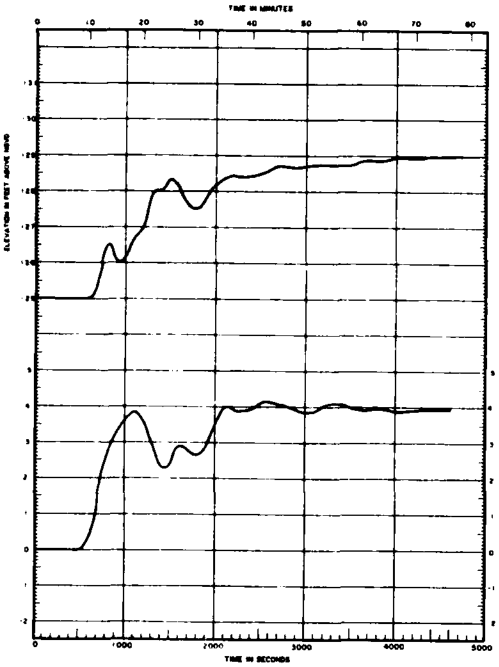
— MODEL DATA

VELOCITIES AND SURGES

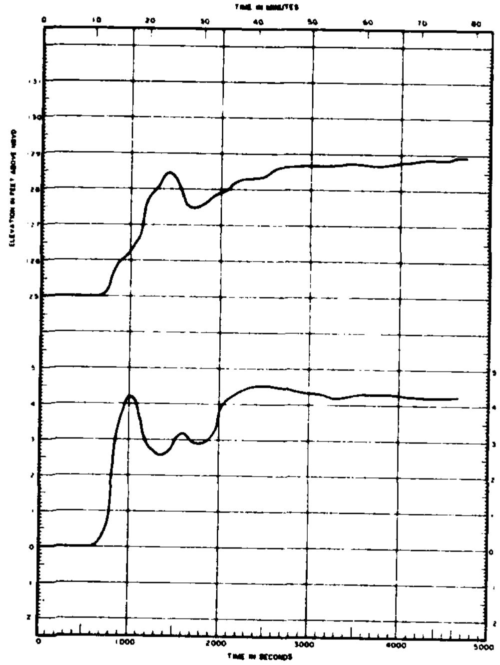
PLAN A

LOCK EMPTYING

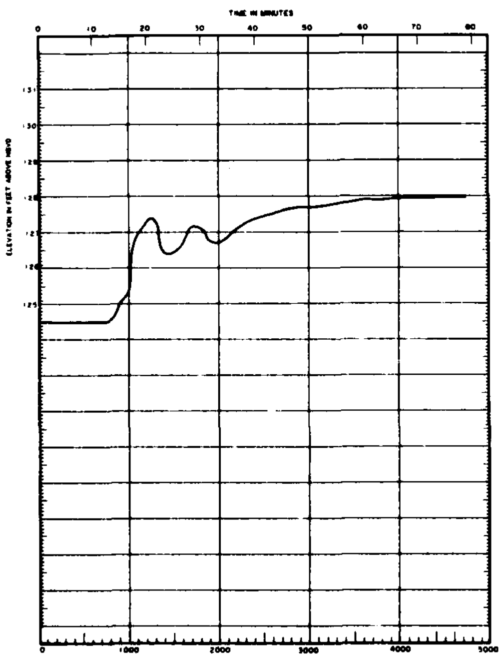
RIVER DISCHARGE	27,000 CFS
POWERHOUSE DISCHARGE	0 CFS
INITIAL TAILWATER EL	125.0



STATION 1



STATION 2



STATION 3

LEGEND

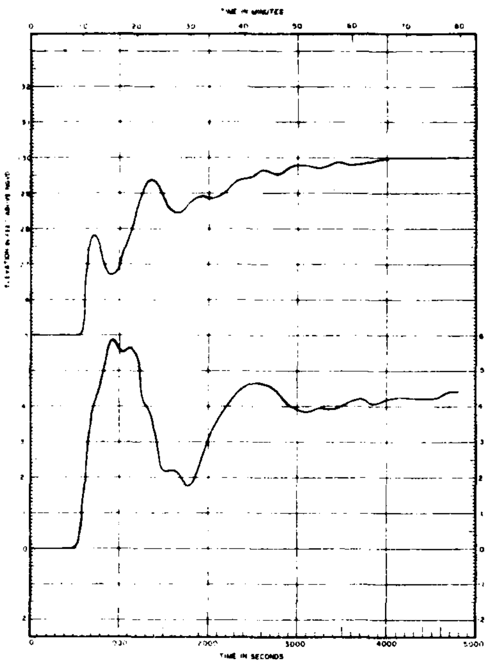
— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 1.

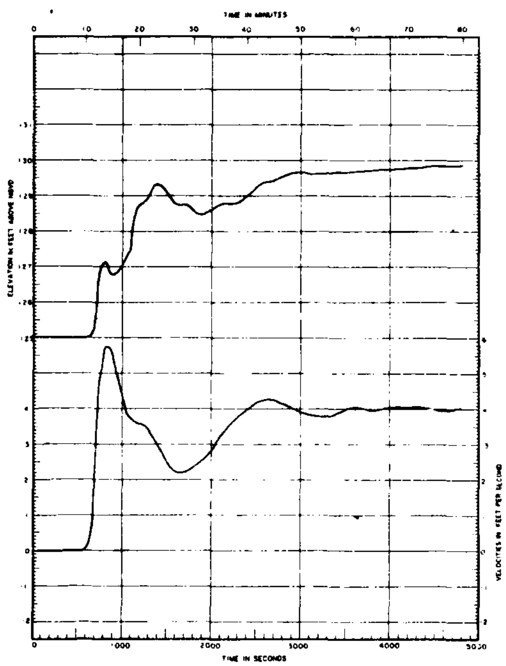
VELOCITIES AND SURGES

PLAN A

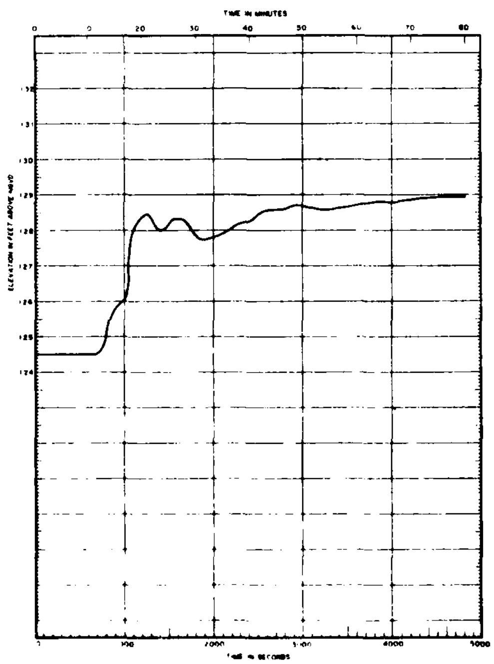
POWERHOUSE DISCHARGE	0-27,000 CFS
RIVER DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	125.0



STATION 1



STATION 2



STATION 3

LEGEND

—— MODEL DATA

NOTE: INITIAL TAILWATER EL AT GAGE NO. 1.

VELOCITIES AND SURGES

PLAN A

POWERHOUSE DISCHARGE	0-27,000 CFS
SIMULTANEOUS LOCK EMPTYING	
RIVER DISCHARGE	27,000 CFS
INITIAL TAILWATER EL	125.0

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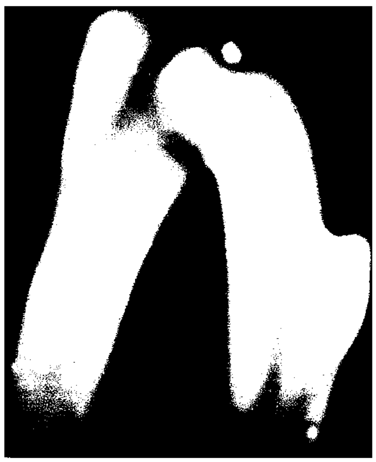

AD-A150 879 NAVIGATION CONDITIONS IN VICINITY OF WALTER BOULDIN LOCK AND DAM COOSA RI..(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS HYDRA..

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UNCLASSIFIED C M MYRICK ET AL. DEC 84 WES/TR/HL-84-11 F/G 13/2 NL

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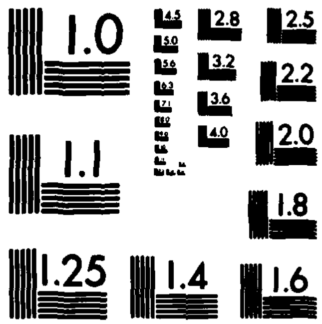

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SUPPLEMENTARY

INFORMATION

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION. CORPS OF ENGINEERS
P.O. BOX 631
VICKSBURG. MISSISSIPPI 39180

AD-A150879

REPLY TO
ATTENTION OF

WESAR

11 March 1985

Errata Sheet

No. 1

NAVIGATION CONDITIONS IN VICINITY OF

WALTER BOULDIN LOCK AND DAM

COOSA RIVER PROJECT

Hydraulic Model Investigation

Technical Report HL-84-11

December 1984

Plates 9-18, 23-28, 31, 32, 35-37, and 39-41:

Change stations 8, 11, 13 to stations 2, 3, 4, respectively.

END

FILMED

5-85

DTIC